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SHELBURNE FALLS POWER PLANTS

Turning the Mountains' Springtime Floods Into Summer Trolley Rides

STRETCHING FROM BENNINGTON, VT., to Providence, R. I., and from North Adams, Mass., to Lowell, runs a spider work of latticed steel towers and shining copper wire, climbing rocky hillsides, wandering through shadowy woodlands, jumping roistering brooks, touching here and there at busy towns and quiet villages, and reaching with the ends of its threads on the one hand, the noisy, bustling manufacturing cities, on the other hand the splash and murmur of water falls and the droning hum of great generators. Unlike the spider web of nature, it is not designed by its creators to draw all who come within its range into a snare, but, on the contrary, to gather up from the rushing streams their strength, and carry this labor saving energy to the aid of those who come within its beneficent influence. From the pouring flood of the Connecticut, in Vermont, from the tumbling falls of the Deerfield in Massachusetts, from the drop of the waters as they flow to relieve the needs of thousands of Bostonians, this system gathers up 180,000 hp., and distributes it into 5 states, as shown in the map of the transmission line.

FIG. 3. LOCATION OF STORAGE, POWER PLANTS AND TRANSMISSION LINES OF THE CONNECTICUT RIVER AND DEERFIELD RIVER DEVELOPMENTS. 1, VERNON PLANT. 2, PLANT NO. 2. 3, PLANT NO. 3. 4, PLANT NO. 4. 5, PLANT NO. 5. 6, SOMERSET RESERVOIR. A, BELLOWS FALLS, VT. B, BRATTLEBORO, VT. C, GREENFIELD, MASS. D, KEENE, N. H. E, HINSDALE, N. H. F, NORTH ADAMS, MASS. G, BENNINGTON, VT.

In the general plan 3 companies are concerned: The Connecticut River Power Co., operates the plant at Vernon, Vt., on the Connecticut River, where 37,000 hp. is generated. The New England Power Co., is organized to develop the power of the Deerfield River, with a storage reservoir at Somerset, Vt., and power plants in operation at Shelburne Falls, the 3 developments totalling 18,000 hp., a plant nearly completed at Hoosac of 12,000 hp., and other plants projected for future development on that river amounting to 16,000 hp.

The first cost of the development will be in the region of $4,250,000 and later additions will bring the probable cost of the completed system to the region of $7,000,000.

Since 1909 the Vernon plant has been in operation, developing 20,000 kilowatts at the switchboard, which is transmitted to Gardner, Fitchburg, Clinton, Worcester and intervening towns. This transmission has been largely at 66,000 volts on the main lines, and at 13,200 on the branch lines, current being generated at 2300 volts at the plant and stepped up to 66,000 and

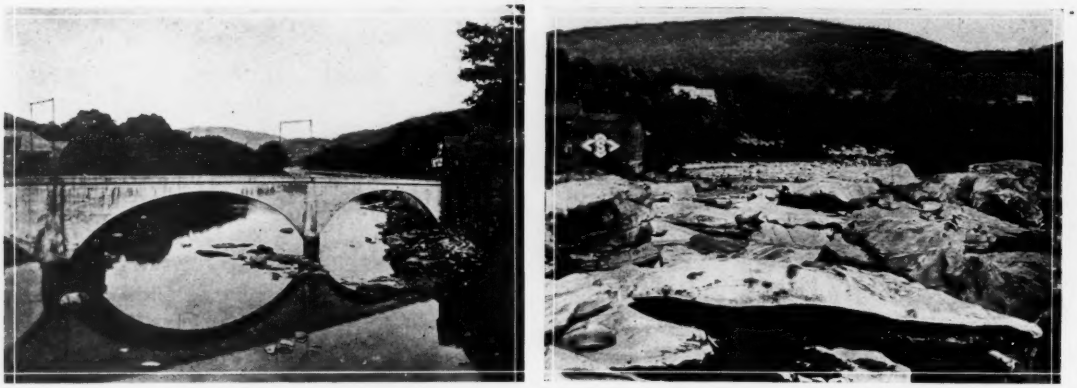


FIG. 1. THE MEAGER FLOW OF SUMMERTIME ABOVE THE DAM, AND THE DRY BONES OF THE STREAM BELOW

The Connecticut River Transportation Co., has the task of gathering power from all these plants and distributing it through sub-stations to the various light, power and railway companies throughout its territory, and incidentally it takes a small amount of power from the plant at Clinton, Mass., operated by the Metropolitan Water Board, which controls the storage reservoir for Boston's supply. This combined organization acts largely as a wholesaling agency to deliver power in large blocks to the local companies which furnish it to retail customers. In some places, however, where no company has heretofore been organized for the selling of electricity, a retail business is done through a local organization. The average rate for power sold in wholesale blocks is a little under 1 cent a kilowatt-hour.

again stepped down at the sub-stations. The main line frequency has been 60 cycles, but at Worcester, Mass., the street railway company has been supplied through a frequency changing sub-station with current at 25 cycles.

Deerfield River Development

FOR the present, our interest is more especially with the work of the New England Power Co., along the Deerfield River. This development begins in the town of Somerset, Vt., at an old site known as Chase's Pond where a dam is now completed which will impound the spring floods for gradual release as they may be wanted. A little later another dam will be built near Davis' Bridge and these 2 storage reservoirs will be able to care for practically all of the run-off in the

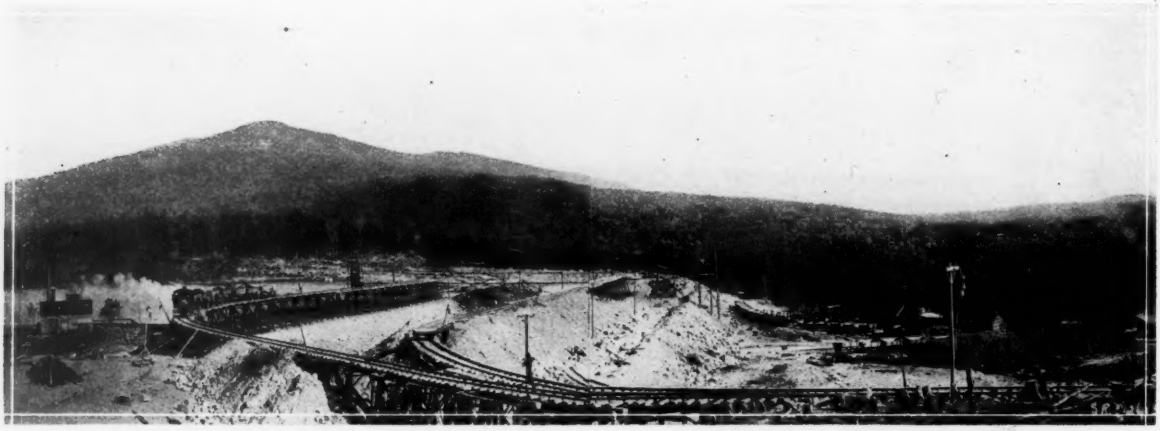


FIG. 4. SOMERSET DAM UNDER CONSTRUCTION, SHOWING TRESTLES FILLING POOL, CONSTRUCTION TRAIN, PUMP HOUSE AND POWER HOUSE

water shed which feeds the river. For the water sheds below, such run-off as cannot be immediately used in the plants, can be taken care of in the ponds at the various power plants.

Throughout the greater part of its length, from Somerset to Greenfield, Mass., the Deerfield River rushes along with rapid fall between steep slopes, making good sites for power development. Between Zoar

FIG. 2. WHEN THE FLOODS OF SPRINGTIME FORM THE "TUMBLING WATERS"

and Shelburne Falls, for a short distance the flow is through meadow and farm land and the fall is not great. Also 10 miles below Shelburne Falls, where the river turns northward, to join the Connecticut, its current again becomes somewhat sluggish. Between Somerset and Shelburne Falls 4 locations have been chosen for development in the final plan; one at the Davis' Bridge dam, with a fall of 300 to 375 ft., depending on the height of the back water, and developing 20,000 kw.; one at Monroe Bridge, where a fall of 65 ft. will develop 4000 kw., one at Hoosac, near the end of the Hoosac Tunnel, where a fall of 200 ft. makes available 12,000 kw., and one at Zoar with a fall of 150 ft., which will give 8000 kw. Beginning at about a mile above Shelburne Falls 4 plants are provided for,

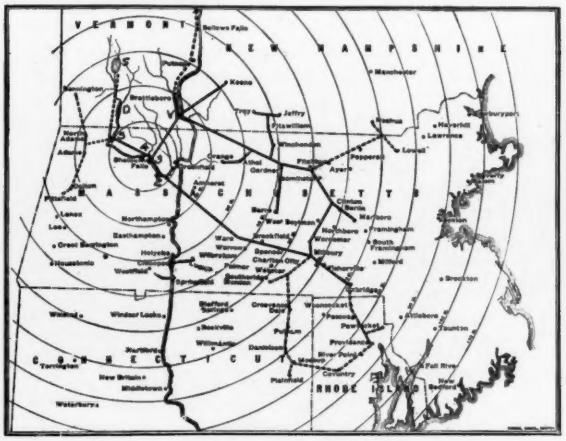


FIG. 2A. MAP OF THE TRANSMISSION LINE

one known as No. 4, near Scott's Bridge, with a fall of 64 ft., giving 6000 kw., one in the village of Shelburne Falls, No. 3, where a fall of 64 ft. makes 6000 kw. available, one at Bardwell's Upper Bridge, No. 2, where 58 ft. will develop 6000 kw., and one at the Bardwell's Lower Bridge to be developed later, where a fall of 40 ft., will make 4000 kw. available. Between and below these developments are some other plants already in operation, either for the generation of electric power or for factory purposes.

With this outline and general knowledge, let us start our trip over the development.

Dropping off the train at Shelburne Falls, where the main office of the Power Construction Co. which has had charge of building the dam and plants is located, we find ourselves in a New England town which is literally "nestling among the hills." The quiet of the village, and the grateful warmth and haze of an early day in autumn are over all, and as we stand on the bridge over the river and watch the peaceful, lazy loitering of the stream, it gives mockery to the other name, Shelburne Falls, the "town of tumbling waters."

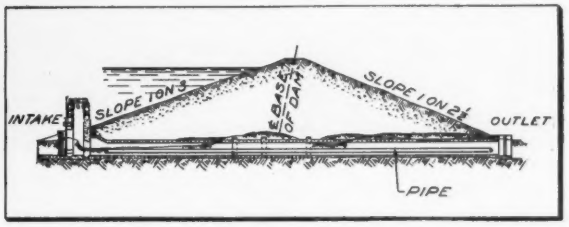


FIG. 5. SECTION OF SOMERSET DAM, CONDUIT, PIPES AND TOWER WITH REGULATING GATES FOR LEVELS

As we turn, however, to the bouldered bed below the dam now bared from lack of water, it is easy to read the record written by the force of the spring torrents with the drive of the mountains behind them, and the name "tumbling" is amply justified.

This Deerfield River, like all mountain streams, is impulsive. Draining 500 sq. miles of steep hillsides, the run-off is rapid and the stream comes in rushes and stops, except when winter's coverlets are being thrown off in the springtime awakening of the hills.

The variation in flow is from an average of 1300 cu. ft. a second to 28,000 cu. ft. a second at flood time in the spring.

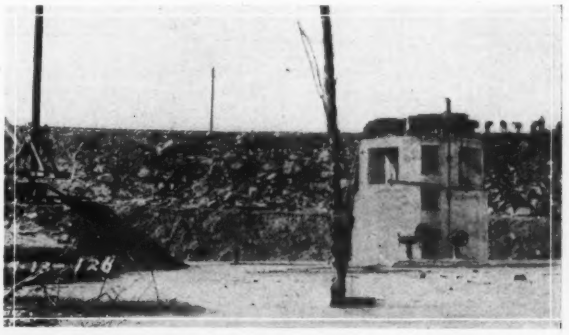


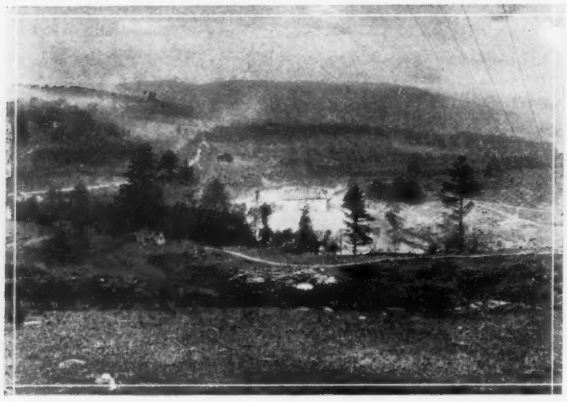
FIG. 6. GATE TOWER DURING WINTER OF 1912

As we are introduced to A. A. Conger, the courteous hydraulic engineer of the construction company, and talk of the development and its purpose, he explains that this "feast and famine" are characteristic of all New England rivers, and that the main plant at Vernon on the Connecticut River is troubled in the spring with a glut of waters so that the wheels are drowned out and the capacity lessened. On the Deerfield River the drop is so steep that drowning out of plants does not happen, but here also prevails a big excess of water in the spring, a deficit in summer. The result is damage to farms and villages and the energy needs control.

The Reservoir at Somerset

TO accomplish this is the purpose of the big storage reservoir at Somerset, where 2,700,000,000 cu. ft. of water will be stored, part of which may be sent through the Deerfield plant in a steady flow during the spring season to help out the loss in capacity at Vernon and part will be retained for the season of drought, thus spreading the spring enthusiasm of the pleted the entire capacity of the Somerset reservoir will be held back for summer use.

From Somerset to Conway, below Shelburne Falls, the Deerfield drops some 2200 ft. of which 1000 ft. can well be developed as water powers. Their value depends, however, on the headwater control of the river, and this will be gained by the Somerset development and by the big reservoir to be built at Davis



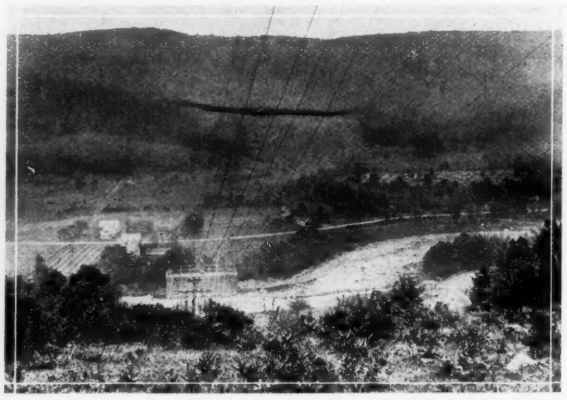


FIG. 7. UP STREAM AND DOWN STREAM FROM SUGARLOAF HILL, SHOWING LOCATION OF PLANT NO. 4. THE OX BOW IS BETWEEN THESE VIEWS

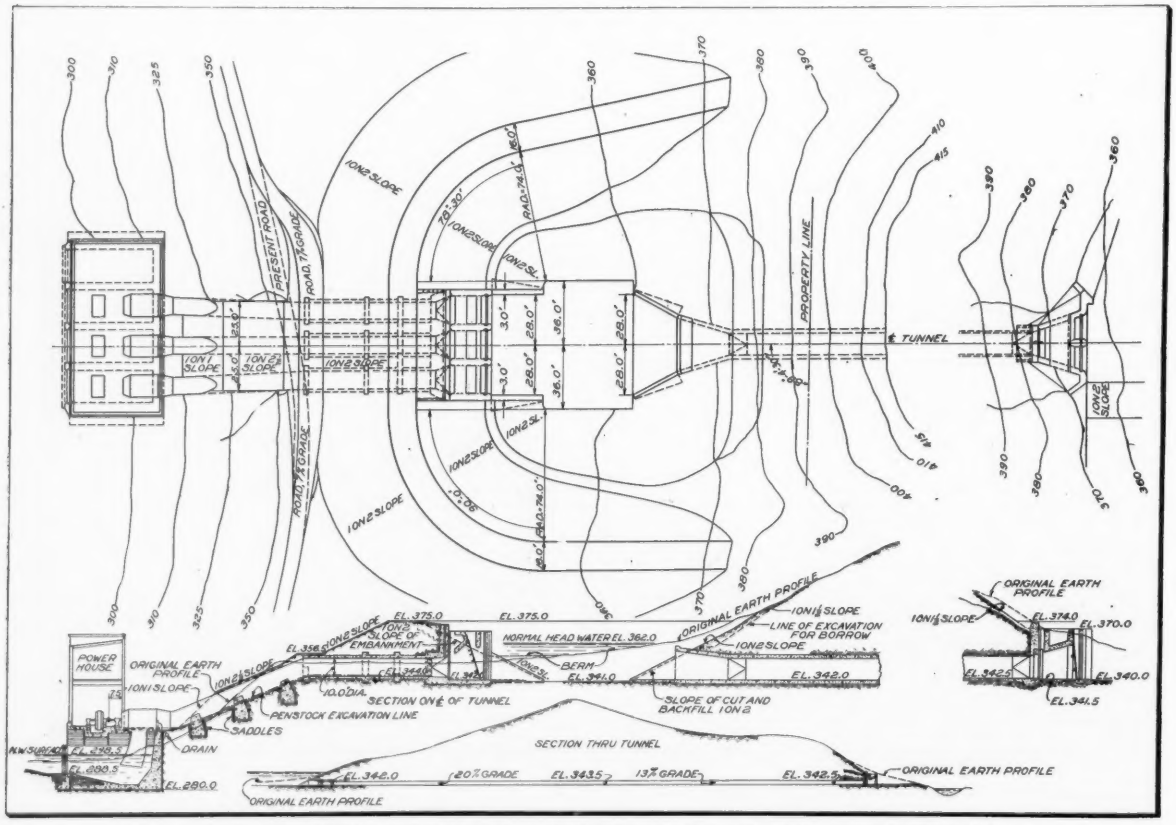


FIG. 8. PLAN AND SECTION OF PLANT NO. 4, SHOWING TUNNEL, FOREBAY, AND POWER HOUSE

Deerfield to balance the discouragement of the Connecticut at Vernon and keep the balance of power steady. Later there will be developments by the Connecticut River Power Co., at Brattleboro and Bellows Falls, Vt., and it is likely that when these are com-

Bridge near the Massachusetts line which will have a capacity of 4,500,000,000 cu. ft., and will work in conjunction and in series with the Somerset reservoir.

This Somerset proposition interests us, as being the source and governing feature of the whole plan, and

we are glad to accept an invitation to go by automobile for an inspection trip. And this swift journey through the hamlets and farms of the New England hills brings strikingly to mind the progress made during a generation. Where, in our boyhood days, the oil lamp and lantern and even the tallow candle were the standard sources of light, now are found farm houses and barns equipped with complete outfits of electric lamps and electric motors. When the ox cart was the standard means of hauling heavy loads (and it has not yet entirely disappeared, for we met one on our journey), are now found the automobile truck, and in place of the horse drawn carry-alls or express wagons which took us to mill and to meeting, are the 7-passenger touring cars and the motor express wagons which cover in an hour what, by the old methods, would have taken a day.

At the old Peck's Mill site at Somerset we find the dam nearing completion. From a great borrow pit near by, the earth is being hauled in train loads, run out on trestles and there dumped to one side and the other, the up stream side being worked to a slope of 3 to 1 and the down stream side a slope of 2½ to 1. Between these trestles the space is filled in by dumping and then sluicing the material towards the center of the pool by means of hydraulic nozzles from which the streams issue urged by a centrifugal pump, and

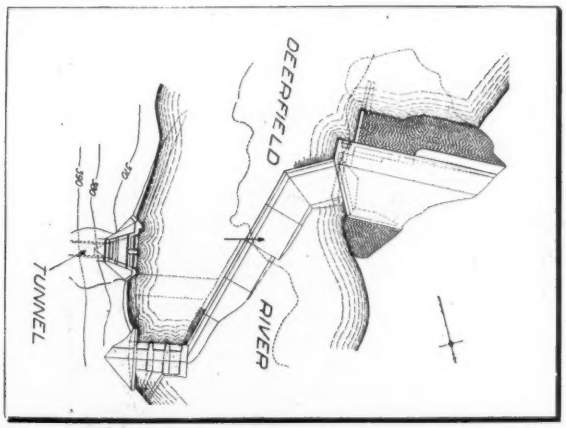


FIG. 8A. LOCATION OF DAM ACROSS DEERFIELD RIVER AND ENTRANCE TO TUNNEL

wash down towards the center the finer material to form the inner portion of the dam. A pressure of 150 lb. is maintained in the hydraulic mains for the sluicing of material, the water being carried to the nozzles by 3-in. special rubber sluicing hose and nozzles 1½ in. in diameter being used. When completed this will be 500 ft. thick at the base with a top 20 ft. wide, and will rise 100 ft. above low water with 4 ft. of splash board on top. The length will be 2000 ft., and the upper slope will be paved to take the wash of the waves. Above the dam the storage will overflow 1800 acres.

During construction, that is, during the season of 1912 and 1913, control of the water has been from a gate house with openings at different heights leading to a 12-ft. concrete tunnel containing 2 4-ft. pipes. These gates, at different heights, served to regulate the drawing off from the surface as the river falls and maintain the water at any desired level, and also can be used to graduate the flow permitted from the reservoir when filling. The spillway is to be cut from solid rock to avoid any washing away by the overflow. The notable features are the height and thickness for an earth filled dam and the tremendous amount of material which has to be filled in in the length to be constructed.

The dam at Davis Bridge will be similar in all features, but will be 195 ft. in height. This work at Somerset is being done directly by the Power Construction Co. already mentioned, of which Geo. W. Bunnell is president, C. F. Cook his assistant, J. N. H. Cornell the general manager in charge of the work at Somerset, and A. A. Conger hydraulic engineer. J. G. White & Co., and Chas. G. Main have been retained as advisory engineers in the development.

Power for Hoosac Tunnel

FROM Somerset, as we go down the river, there are occasional small developments for local uses, but the river tumbles and rushes on its way to a point somewhat below Monroe Bridge, where the sharp drop makes available a head of 200 ft. by carrying the water through a conduit and canal for 2½ miles below the dam. This plant is called No. 5 in the company's plans, or the Hoosac Tunnel Plant, and at present is equipped as a transformer and frequency changer station.

Power for the locomotives which draw trains through the Hoosac tunnel is supplied at 25 cycles per second and to the feeder lines at 11,000 volts. It is necessary, therefore, in supplying power for this system to change the 60-cycle current from the Vernon plant to 25 cycles, and this is done by means of frequency changers installed in the Hoosac plant. These changers are of peculiar design, arranged so that current may be taken in at either end and taken out at the other end; also they may be driven from the water wheels of the plant when these later are installed, so that the plant may furnish 25-cycle current direct to the Hoosac tunnel lines, or the water wheel may furnish part of the power and the rest may be transformed and sent through from the 66,000-volt lines, using the generator as a frequency changer.

The installation of water wheels for use of the water power at the Hoosac Tunnel Plant is not yet completed, but is well under way.

Tunneling a Hill

AS we pass on down the river road, we travel beside quiet water, past Charlemont between smiling farm lands, until we reach a point 1½ miles above Shelburne Falls, where the fretting hills again rise and turn the stream first north, then east, then south, the North river meantime joining in its forces.

Here comes the first of the Shelburne Falls developments, known as No. 4, or the Scott's Bridge Plant, with an unusual feature for eastern power plants; in order to take advantage of the drop around the Ox Bow, a 1600-ft. tunnel has been run under Sugar Loaf Hill, and a dam built at the beginning of the Ox Bow, 235 ft. long and 50 ft. high, with 4 ft. of splash boards. It is of concrete construction, 28 ft. thick at the base and 4 ft. at the top, and is built inclined across the bed of the stream in order to give a greater length of spillway in time of spring floods. At one end this dam butts against solid rock with sluice gates facing down stream, and at the other end it faces into an embankment with a gravel abutment and with rip rap upper face and a single small submerged sluice gate to take away the force of undercutting current.

At right angles to the flow of the river is the inlet to the tunnel which carries through the hill and discharges into a forebay from which head works and pen stocks lead to the power house. To control the flow of water into the tunnel, a gate equipment, supplied by the Exeter Machine Works, of Pittston, Pa., is used, the gate, which is 13 ft. 18 in. high and 14 ft. wide, being built of steel plates and 26-in. I beams, and sliding on a ¾-in. bronze wearing plate, it is raised and lowered by a pair of 5-in. steel screw stems, having at the top horizontal beveled gears driven by a cross shaft, which in turn is operated by a 15-hp. motor driven by current at 2300 volts from the power house over the hill. The sluice gates, which are 42 ft. wide, have 3 openings, each 10 ft. wide, controlled by timber head gates, and a submerged gate corresponds with the submerged sluice at the upstream end of the dam. The combined capacity of submerged and surface sluices is about 4200 cu. ft. a second, so that by their use it will be possible to control smaller flood rushes of water which otherwise might raise the water level above the flash boards and cary them away. With the use of 4-ft. flash boards, the pondage will be about 300 acre-feet, and with 8-ft. flash boards, 400 acre-feet.

The tunnel through the hill is of horseshoe section with a flat bottom 9 ft. wide, a height of 13 ft., and a width of 12 ft. 6 in. at the largest diameter. As shown on the drawings, outlet and inlet are made with diverging walls to reduce the loss of head, and screens are provided at the inlet to prevent the entering of trash.

The tunnel has a normal capacity of 1500 cu. ft. a second, with area of 134 sq. ft., and is sloped gradually depth of water, the down-stream curve of the embankment being used as location for the head works of the penstocks.

From the plant No. 4 is carried over to the dam, a 2300-volt wood pole line for transmitting power to operate the motors of the gates, and a telephone line is also installed. Along the same right of way runs the

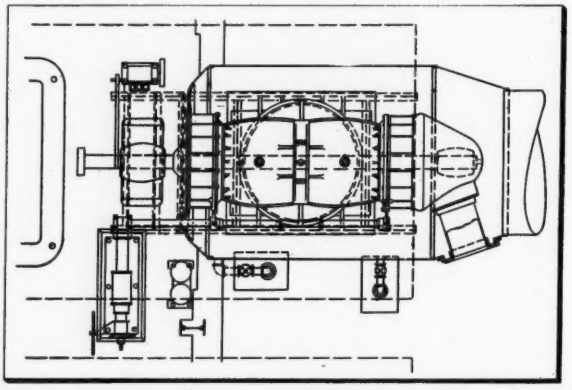


FIG. 10. SECTION OF WATERWHEEL SETTING; ALIKE IN ALL PLANTS

steel tower transmission line which carries on to the Hoosac Tunnel Plant and will there connect with lines to be built to Davis Bridge, Somerset, North Adams, and Pittsfield. A forest of steel towers carrying wires and outdoor disconnecting switches are built on the embankment below the headworks of the forebay and are seen in the view of plant No. 4 from the river.

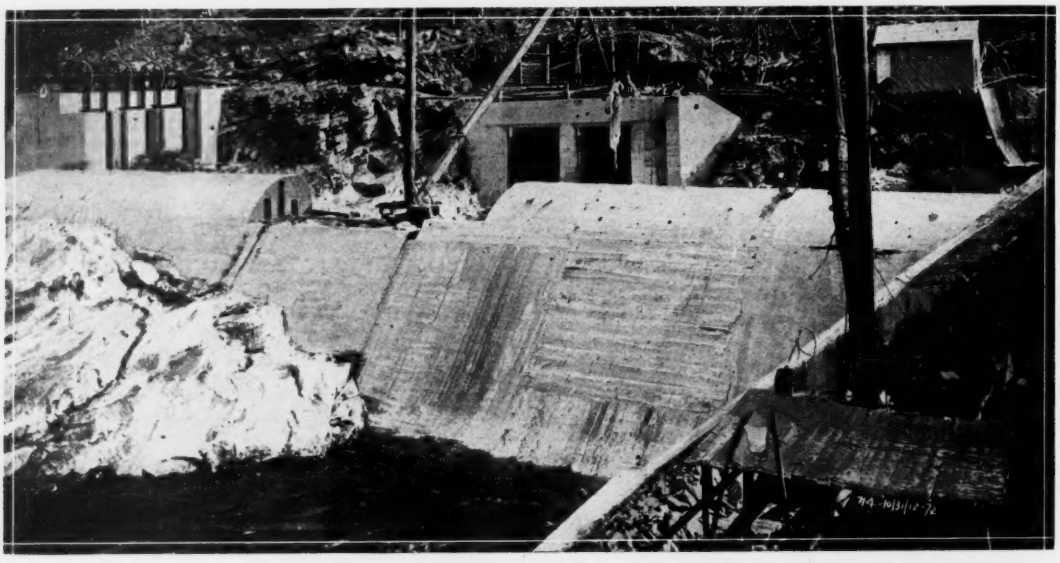


FIG. 9. VIEW OF DAM AT SCOTT'S BRIDGE WITH SLUICE GATES AT LEFT AND TUNNEL INLET IN CENTER OF VIEW

each way from the center so that it can be completely drained of water when desired. From the upper end 1445 ft. passes through rock, and the other 155 ft. at the outlet end is through earth, the rock having a concrete lining and the earth a brick lining, the thickness being from 20 to 24 in. At the outlet end is a horseshoe-shaped embankment with ends tied into the hill and with sides sloped 2 to 1, and surfaces where they come in contact with the water completely rip rapped. This gives some 12,000 sq. ft. area, and 33 ft.

Penstocks and Waterwheels

THE principal details of the pen stock and headworks construction are shown in the sectional view of plant No. 4. The headworks has 3 concrete bays to supply the 3 penstocks, which are of steel 10 ft. in diameter and 160 ft. long and built of ¼-in. and 5/16-in. plate, with stiffening rings spaced 20 ft. apart. The first 80 ft. is horizontal, laid in a concrete jacket, and the lower 80 ft. is laid in a slope of 2½ to 1 on con-

crete saddles, placed 20 ft. on centers, with the penstock back-filled and covered with earth. At the upper end, each penstock is closed by stop logs in grooves, screen and 2 timber head gates, each 7 by 12 ft. with steel screws, and one having a 24 by 24-in. filler gate. A 12-in. open vent leads from the upper end of the penstock to prevent formation of vacuum in the upper end when draining the wheel case.

The 3 waterwheel equipments are exactly alike. In each case is mounted a double runner on one shaft, taking water at the circumferences, and discharging at the center. The wheel cases are 13 ft. in diameter with cone ends and reinforced lower end through which the shaft is carried. This shaft is supported on 2 ring-oiling, self-alining bearings with thrust collars in the front bearing, which is outside the case in the power house and is water-cooled. The rear bearing is contained inside the case in a deflector cone and can be inspected and cared for through a tube connecting this cone with the shell of the wheel case. The wheel casings are outside the station buildings, with the down-stream ends projecting through the station wall. This wheel equipment was furnished by the Wellman, Seaver, Morgan Co., of Cleveland, Ohio, and each unit is controlled by a Lombard special horizontal governor, operated by compressed air which is furnished by a compressor driven from the waterwheel.

The 3 plants in the Shelburne Falls development are alike in plan and detail with 2 exceptions; in the No. 3 plant, located in Shelburne Falls village, as the main line for the transmission does not pass through the power house, less switching apparatus is needed, and the second story is carried up on only half of the building; at No. 2 plant, the station is immediately below the dam so that the penstocks are shortened and given a much sharper incline.

Electrical Plan of Stations

DIRECT connected to the shaft of each waterwheel, is a General Electric 2000-kva. generator, running at 257 r.p.m. and generating 3-phase current at 2300 volts and 60 cycles. From the generator, current is

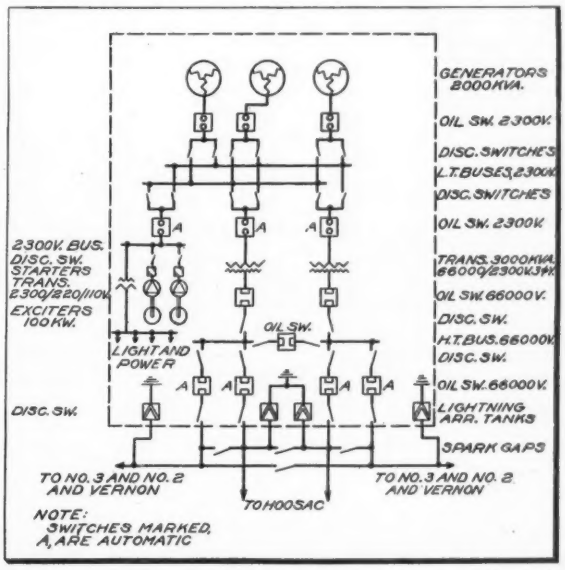


FIG. 10A. SCHEME OF CONNECTIONS OF NO. 4 PLANT FOR GENERATORS, EXCITERS, TRANSFORMERS, INCOMING AND OUTGOING LINES

taken through an oil switch to a disconnecting switch and thence to the 2300-volt bus bars from which it goes through a disconnecting switch and oil switch to either

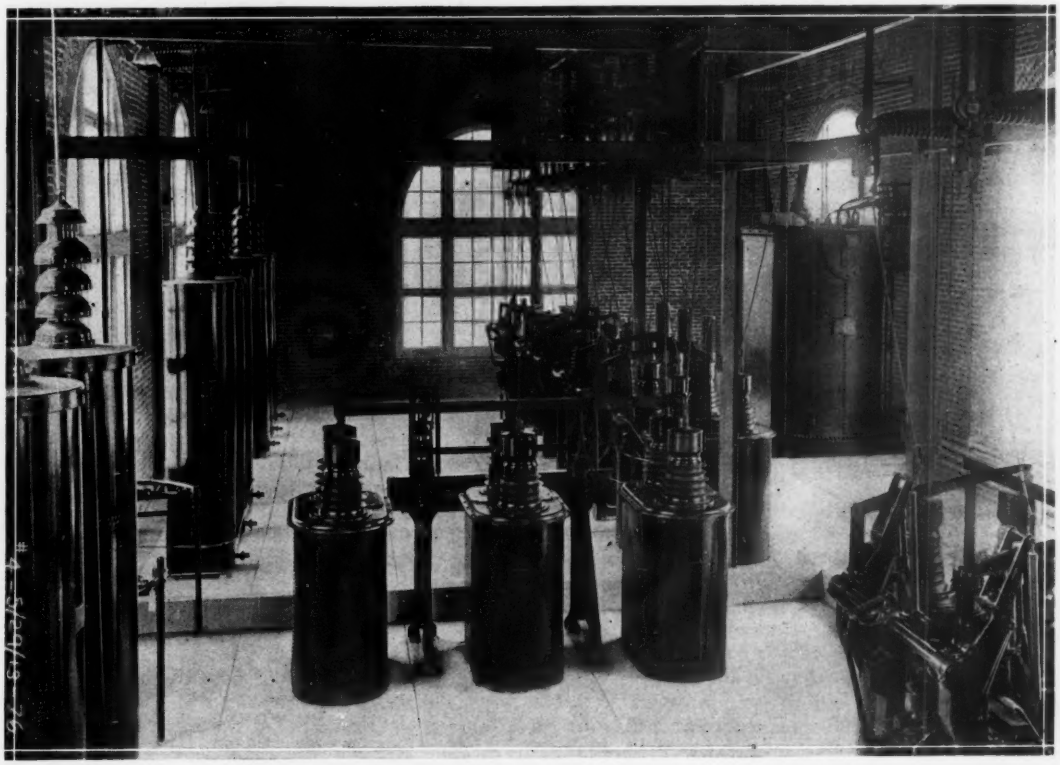


FIG. 10B. VIEW IN THE SWITCHROOM AT NO. 4 PLANT, SHOWING OIL SWITCHES, DISCONNECTING SWITCHES, TRANSFORMER AND ELECTROLYTIC ARRESTER CELLS

of 2 transformers which raise the voltage from 2300 to 66,000. From the secondaries of these transformers, oil and disconnecting switches carry current to the high-tension bus bars, and from these bars disconnecting switches and oil switches go to the transfer buses and then to the line. The 66,000-volt lines are in duplicate, running through plant No. 4 from Hoosac and on past No. 3 plant and through No. 2 plant to the Ware line and connecting near station 3 with the line to Vernon. The connection and switching system at No. 2 plant is the same as at No. 4 and is shown in the diagram, switches being arranged so that any generator can be thrown on either of the outcoming or ingoing lines or any and all generators and lines may be thrown in parallel.

Since this current may always be obtained over the transmission line from some source, all exciters are motor-driven, avoiding the need of using separate small waterwheels. A special bus carries 2300 volts, taking current from the generator buses through disconnecting switches and oil switches. From this service bus also a transformer steps down to 220 and 110 volts to furnish light and power about the station. The exciter units are located on the main floor at one end of the generator room, and 2300-volt bus bars are contained in cells on that level.

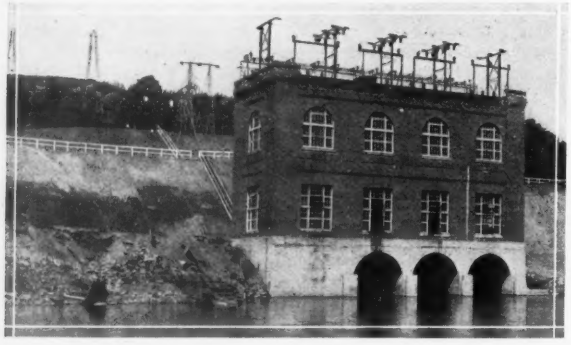


FIG. 11. NO. 4 PLANT FROM THE RIVER WITH FOREBAY AND TRANSMISSION LINE IN THE BACKGROUND

In the second story are the step-up transformers for high voltage with the oil switches and buses, and also the aluminum cells for the electrolytic lightning arresters, the horn gaps of which are mounted on the roof of the station. This arrangement is the same as in plant No. 2 and is shown in the vertical, sectional view of that plant. (Continued in Dec. 15 Issue)

BRICK BOILER FURNACES

Practical Suggestions for Building Boiler Settings

By W. O. Jones

THE tendency of brick boiler walls to crack has led to the evolution of the steel boiler casing which encases the brick and eliminates troublesome cracked walls. When the casing is used, it is lined with brick from 9 to 13 in. thick, and sometimes it also has a course of asbestos or magnesia as an additional insulator.

While these settings have a merited popularity where they are known, there are many who adhere to the old style brick walls. Economic conditions do not always warrant the use of the steel casings. A further discussion of the casings would be a digression from the subject of this article and the writer will not discuss it further at this time; but if any of the readers are interested, their advantages will be explained in a later issue.

No set rules or specifications could be prepared for the building of boiler furnaces that would insure walls that would not crack sometimes; but the stability of the walls depends materially on their structure. Generally speaking, it does not pay to let the building of boiler furnaces out by contract; it is best to buy the material and pay a good man, or good men, by the day.

The cracking of boiler furnace walls is caused: first, from their expansion and contraction; second, by the load that is on them when the boiler is supported by brackets which rest on the walls, and third, by the settling of the foundations. The effects of the first cause can be mitigated by the use of a carefully prepared mortar, care in laying the brick, and keeping the furnace well housed. The cause, however, cannot be entirely eliminated and the utmost precautions are not always effective, consequently sooner or later cracks will sometimes develop. The second cause can be entirely eliminated by swinging the boiler from overhead girders, so that no part of its load is sustained by the walls. The third cause is inexcusable in some localities and in others it seems almost impossible to obtain foundations that are perfectly solid and compact.

Buckstays are sometimes used, and perhaps are of some value, but they have never solved the difficulty entirely.

The specifications below are used by the writer for brick boiler furnaces and have been found suitable for practical use:

"The masonry must consist of red brick laid in lime mortar tempered with cement for the outside courses, and fire brick dipped in thin fire clay paste for the inner course in the heat zone of the setting. All red brick shall be machine made, with smooth surface and square corners, all of uniform size. The brick must be well burned and not less than 75 per cent hard.

"The mortar to consist of sand, lime and cement in the proportions of approximately 12 :3 :1 respectively, which should be thoroughly mixed in a dry state until no streaks of cement or lime are visible. Then water should be added and the whole thoroughly mixed until a homogeneous mass is produced. The mortar should be mixed in small quantities and used before it begins to set.

"All mortar joints to be not less than ¼-in. or more than ⅜-in. in thickness, and each brick laid with full joints at sides and ends.

"The brick shall be laid headers and stretchers with one course of headers to every 5 courses of stretchers, and arranged so as to bind thoroughly the wall in every direction. The exposed face of the masonry shall be smooth, all joints struck full, and all brick in the outside face of the setting selected of one color.

"The fire brick in the furnace portion of the setting must be of the best quality, but the brick beyond the furnace portion may be of second quality. All fire brick must be of uniform size, machine made, and dipped in thin fire clay paste and shoved in place. Fire clay batter of such thickness that it can be handled with a trowel should not be used.

"The fire brick must be laid headers and stretchers, every fifth course being a header course, except in the furnace at the sides of the grates, where all fire brick must be turned headers to a point 12 in. above the grates."

DESIGN OF THE RITES GOVERNOR

Experiments Which Led to Present Design; Formulas and Moments Governing Design

By Sterling H. Bunnell

DEVELOPMENT of the centrifugal shaft governor into the inertia governor came about through a series of steps. Some of these steps are evident in the series of patents issued to F. N. Rites during the years in which his now well-known governor was in course of development. The effect of inertia by which the 2 opposing weights of the centrifugal governor are checked in their movement from an inner to an outer position was observed early in the course of studying existing governors. Recognizing the advantage of the inertia effect in preventing the governor weights from jumping from one position to another, Mr. Rites at first tried various forms of weight. He expanded his weights into large rings surrounding the shaft center, still keeping the center of gravity of the weight in the original position, but placed the mass of the weight at a greater distance from the center of gravity. In this way the rotation of the weight around its pivot point caused a large angular displacement of the mass of the weight itself, and increased the slowness of movement.

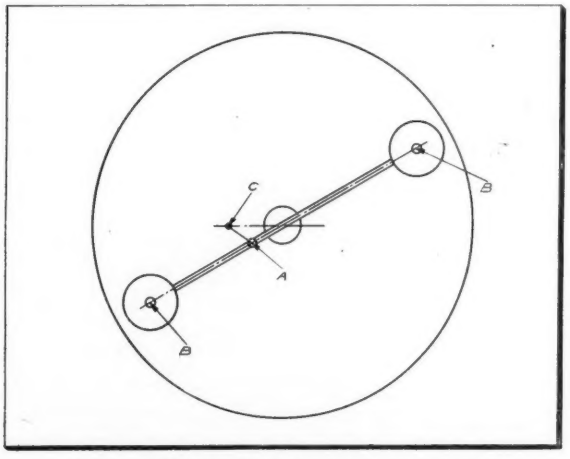


FIG. 1. SIMPLE DIAGRAM OF RITES GOVERNOR

Somewhere about this point in the study must have come the discovery that the enlarged ring weight could be utilized as an inertia ring which would overrun the flywheel of the engine when the speed of the engine is checked, or fall behind when the speed of the engine increases. This gave rise to an extremely quick-acting form of governor. The inertia effect being sufficient to prevent objectionable oscillations or jerks, it was possible to omit one of the weights, and to depend upon a single weight of expanded form. The inertia of the single weight is able to overcome the momentary effect of gravity, and without the aid of an opposing weight to balance the gravity action, the single inertia weight maintains its position during the revolution of the engine without sufficient movement to affect the valve motion objectionably.

The final well known form of the Rites governor thus became that of the straight bar, with enlarged extremities. The inertia masses are the 2 enlarged portions of the end of the bar. These masses are made of proper size, to bring their combined center of gravity at a point a short distance from the center of the shaft about which the governor revolves. The governor thus acts as if it were composed of a heavy mass concentrated at a point A (Fig. 1) near the center of the shaft, and 2 heavy masses concentrated at points B B at a considerable distance from the shaft center. The whole governor arm is pivoted at point C.

It is evident that the governor which can be so simply diagrammed is controlled by several simple forces. The effect of each of these forces has direct bearing upon certain qualities of the governor.

Formulas by which the various elements of the Rites governor may be calculated are correspondingly simple. Referring to Fig. 2, the Rites governor arm in its usual form is shown in outline, with the various important points marked. In designing such a governor to actuate a proposed valve motion, these formulas may be readily applied, and with the certainty of producing the desired result. In these formulas,

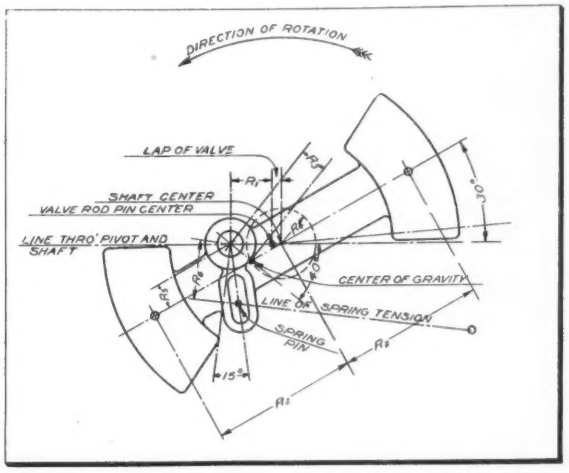


FIG. 2. OUTLINE OF RITES GOVERNOR IN USUAL FORM

those familiar with the laws of physics will note that the moments should be stated in terms of mass, and not of weight. For the commercial purposes of the designer, however, the weight figure has been used in every case, and the constants in the formulas are computed accordingly.

The action of the governor depends upon 4 principal moments. The first is the moment of the reciprocating parts of the valve motion, and is measured by the weight of the parts multiplied by R_1. This moment tends to shake the governor arm backward and forward, as it revolves about the engine shaft, and the inertia effect must be made sufficiently great to control it within reasonable limits. The moment of inertia is measured by the weight of both ends of the arm, multiplied by R_2. This moment must be made great enough, by increasing the weight of the ends of the governor arm and the radius of the center of gravity of these ends from the center of the shaft, to give the desired steadiness.

In designing the governor, therefore, the moment of inertia must be several times as great as the moment of the reciprocating parts, and the coefficient required in designing the governor was named by Rites the capacity. For various revolution speeds, the capacities should be made at least as great as given in the following table:

For r.p.m.....	100	200	300	400	500
Make capacity...	150	100	60	40	30

The moment of gravity effect is one of the disturbing forces, which tends to shift the position of the single-arm Rites governor twice during each revolution. This moment is measured by the weight of the entire arm, multiplied by the distance of the line of action of this weight from the pivot point of the governor arm; that is, by radius R_4. This arm again is opposed in its effect by the moment of inertia. If the moment of gravity be recalculated, and divided into the calculated moment of inertia, the quotient is the "balance" of the governor. There is no definite figure for the balance, but it gives a convenient guide for comparing the design of one governor with another.

The moment of centrifugal force is the controlling one which produces the desired effect of the governor in regulating the engine speed. The centrifugal force of the governor is found by the formula: $0.000{,}028 \times W R_4 N^2$, in which W is the entire weight of the arm; R_4 the radius of the circle described by the center of gravity, and N the number of revolutions per minute. The moment of this centrifugal force is measured by the radius R_5 at which it acts to turn the governor arm about its pivot point. The combined formulas give the following: Moment of centrifugal force = $0.000{,}028 \quad R_4 \times R_5 \times$ r.p.m.$^2 \times$ weight of arm.

The moment of inertia must be considerably greater than the moment of centrifugal force, if the governor is to have sufficient steadiness in operation. This coefficient is termed the "stability," and should always be made greater than 5. In designing the governor, therefore, if the moment of inertia divided by the moment of centrifugal force is not equal to 5, or a greater figure, the moment of inertia must be increased, by adding weight or length to the arm, or the moment of centrifugal force must be reduced, by taking off weight from the heavier end, so as to reduce R by bringing the center of gravity nearer the center of the shaft, or the radius R may be decreased by bringing the pivot point nearer the center line of the governor arm. Any of these changes will affect other moments, and their effect must be noted and compensated, if necessary, in some other way.

Another coefficient measuring the action of the governor is the "starting strength," which is the quotient obtained by dividing the moment of centrifugal force by the moment of reciprocating parts. The starting strength, it is found, should equal the stability at a speed of 300 r.p.m. If, therefore, the governor is designed for some other speed than 300, the moment of centrifugal force, and the moment of reciprocating parts, must be recalculated for 300 r.p.m. and the stability and starting strength computed for this speed, to see whether this condition is fulfilled.

There remains only the spring tension as one of the acting forces holding the governor arm in its position. The spring strength can be easily calculated from the moment of centrifugal force, by dividing this moment by R_6, the radius at which the spring acts. The calculated value will, however, be too great, because no account has been taken of the effect of the reciprocating parts, which act through their inertia so as to assist the spring. Increase in the weight of valve motion parts or, in fact, increase in the friction of the valve rod in its stuffing box, or of the valve on its seat, has the same effect as an increase in spring tension. It is customary to allow for this fact by making this spring stiffness about 80 per cent of the calculated value. The spring strength should be figured for the inner and outer positions of the governor arm, and the difference between the figured pulls, divided by the distance through which the spring pin moves, gives the extension of the spring in pounds per inch. From this figure, the spring dimensions can be taken from a spiral spring table, or if preferred, the dimensions can be calculated by the usual rule in engineers' pocket handbooks. The spring tension will usually be found equal to about 40 per cent of the spring radius, R_6. That is, with a spring radius of 6 in., the spring will have to be screwed up about 2.4 in. to give the proper speed.

The successive operations in designing the Rites governor are therefore as follows:

The pivot pin is located as near the shaft as the general requirements of strength in the flywheel hub, manner of fastening governor pin, cap, and the like, will permit. Through the pivot pin a line is drawn through the engine shaft, and in the direction opposite to the engine rotation an angle of 40 deg. is laid off, and a line drawn through the pivot on which the center of gravity is to fall. The center line of the governor arm is next drawn through the shaft center, making an angle of 30 deg. with the line through pivot and shaft center. For speeds much above 300 r.p.m. it is better to increase this latter angle from 30 deg. to 60 deg. On the center lines, the governor arm is now blocked out of a size which seems suited to the engine. The various radii are dotted on the drawing and scaled and set down on paper for reference. The "capacity" is selected from the table in accordance with desired speed of operation. The moment of reciprocating parts, and the moment of inertia, are then calculated, and dimensions altered if necessary, to make the quotient of the moments agree with the selected capacity figure. The moment of centrifugal force is next calculated and divided into the moment of inertia, to see whether the stability figure is greater than 5, as desired. If not, the center of gravity must be brought nearer the center of shaft, by increasing the weight at the long end of the arm, or decreasing the weight at the short end of the arm; or both increased until the stability becomes as it is desired. The moment of inertia, the moment of reciprocating parts, and the moment of centrifugal force must next be calculated for 300 r.p.m., and the stability and starting strength obtained for this speed, to see whether they are equal, or approximately so, for a speed of 300. Finally, the moment of centrifugal force is divided by the radius at which the spring acts, to obtain the required tension of the spring.

It will be noticed that the direction of the line of action of the spring is immaterial, as long as the perpendicular distance R_6 from the pivot point of the governor arm to the line of action of the spring is correct. The end of the spring which is secured to the wheel, may be placed at any desired point, so as to connect to one of the arms of the wheel, or to the rim, as preferred. The center line of the slot in which the

spring pin is secured is then dropped back 15 deg. from a line at right angles to the spring line as shown. The slot should allow a reasonable range for adjustment of the spring leverage, so as to give perhaps 20 per cent increase or decrease of the center radius as may be found desirable.

It is evident that variations in castings may change the action of the governor somewhat from the calculated figures. Extra thickness on either of the governor arm ends will have the effect of shifting the center of gravity farther from, or nearer to, the center of the shaft. The location of the governor stops on the arms of a flywheel cast in the usual way by arm and hub cores, may allow the center of gravity to fall too close to the center of the shaft. All these slight changes can be compensated by bolting small weights to the governor arm on either end, as desired.

The adjustment of the Rites governor requires experience and judgment on the part of the erecting man. But, in both design and adjustment, the Rites governor is still perhaps the simplest of all types in general use today.

MIXED-PRESSURE STEAM TURBINE

With Special Reference to the Steam Regenerator

By E. D. Dickinson

IN the early days of the development of steam turbines, it was apparent that the steam turbine could be easily modified to suit special cases, where the steam engine was not readily applicable. It is the intention of the writer to describe briefly one of the more important special uses to which the steam turbine has been put in commercial practice.

The low-pressure turbine cannot properly be considered a special machine; it is essentially a turbine designed to operate on steam at a pressure much below that generated in the boilers. As generally understood, the term "low-pressure turbine" means a turbine designed to operate on exhaust steam at about atmospheric pressure, and for this reason must discharge into a vacuum. In such a machine the number of rows of buckets does not have to be so great as in a high-pressure turbine of the same speed and capacity, for the reason that the energy in the steam is much less. On the other hand, however, in order to get the same power a great deal more steam must be used. The available energy in a pound of steam from atmospheric pressure to a vacuum of 28 in. is only about half that between 150 lb. pressure and the same vacuum; therefore, a low-pressure turbine of a given capacity must have steam passages, nozzles, buckets, and condenser connection of approximately twice the size required for a high-pressure turbine of the same output.

The first and most obvious application of the low-pressure turbine is in connection with noncondensing engines, many installations of this character having proved most profitable investments. The increased capacity has been secured at a very low price per kilowatt, and the greater output has materially reduced the cost of power.

The second and less apparent use for the low-pressure turbine is in connection with engines already operating condensing. Of course, in such installations, when combined with a turbine, the engine would have to exhaust against some pressure above the vacuum in the condenser, generally about 15 lb. absolute, or near that of the atmosphere.

The fundamental reason warranting such a radical installation is that the turbine can be built to give a higher efficiency than the engine over the very low-pressure ranges; that is, it can extract a larger amount of power from steam expanded to the high vacuum attainable with modern condensing machinery.

In stations where the engines are in good repair and have sufficient capacity to drive their generators when running noncondensing, a large amount of additional power can be secured at low cost by the installation of a low-pressure turbine.

In those cases where there is a sufficient supply of low-pressure steam at all times, the straight low-pressure turbine fulfills all requirements. In cases where the load carried by the low-pressure turbine is in parallel with that on the engine and fluctuates with it, the turbine may be regarded as an additional low-pressure cylinder.

There are many places where the supply of low-pressure steam is not constant, or where it cannot be relied upon, and some places where it is desired to

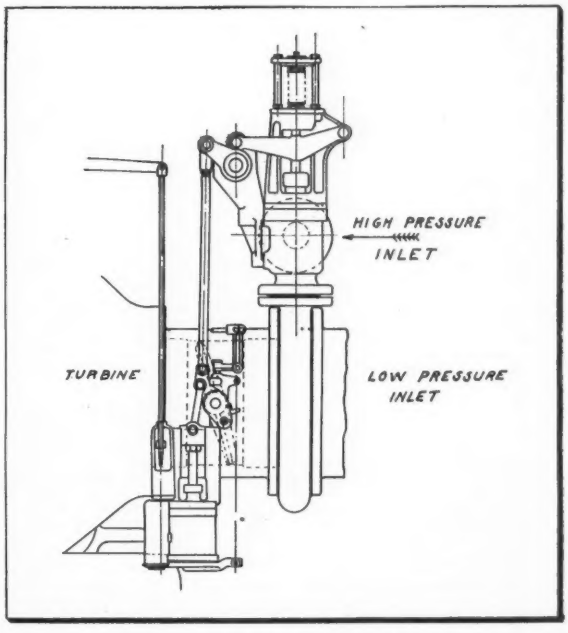


FIG. 1. GOVERNOR OPERATED REDUCING VALVE FOR AUTOMATICALLY ADMITTING HIGH-PRESSURE STEAM IN A LOW-PRESSURE HEADER

secure somewhat more electrical power than can be generated from low-pressure steam alone. The simplest method of securing the required power is to admit high-pressure steam to the low-pressure pipe at times when the supply of low-pressure steam is insufficient. This can be accomplished automatically, either by a reducing valve, set to maintain a fixed pressure in the low-pressure header, or by providing a special valve, operated by the governor. A simple arrangement is shown in Fig. 1. The pressure-operated reducing valve has one inherent defect; viz., it

is extremely difficult to maintain a valve that will work positively, maintain the required pressure, and shut off tight when there is sufficient low-pressure steam. Any steam that passes at such time is lost.

Straight low-pressure turbines are best suited for installations where there will be an adequate supply of low-pressure steam at all times. Arrangements can

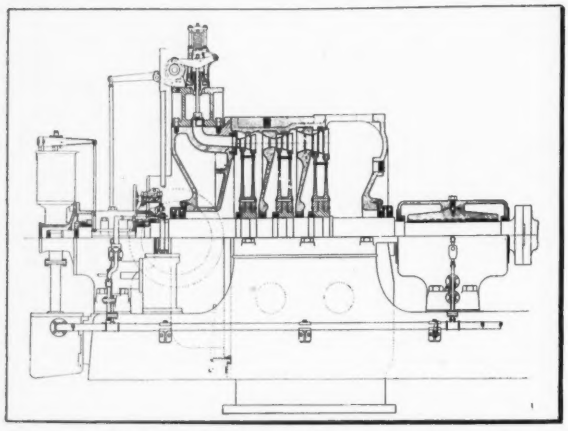


FIG. 2. MIXED-PRESSURE TURBINE PRIMARILY FOR LOW-PRESSURE BUT WILL OPERATE WITH FAIR EFFICIENCY ON HIGH-PRESSURE

be made so that high-pressure steam may be admitted to the low-pressure header, should the supply be interrupted by accident to the engine from which the low-pressure steam is taken. The straight low-pressure turbine is the simplest, and will give the best efficiency.

The Mixed-Pressure Turbine

THERE are many instances where the amount of electrical power required is in excess of that which can be generated by the continuous supply of low-pressure steam. These have called for a special machine designed to operate from 2 separate sources of steam. Machines of this type have been given the name "mixed-pressure," and have been developed in

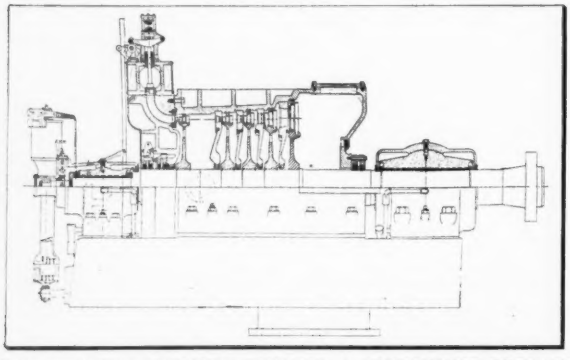


FIG. 3. MIXED-PRESSURE TURBINE, A COMPROMISE BETWEEN HIGH AND LOW-PRESSURE AND CAN OPERATE EXCLUSIVELY ON EITHER

several forms. To get the best results from a given installation, it is essential that the machine be of the form intended for the conditions under which it is to operate. The various forms may be divided into 3 general classes:

(1) Turbines designed to give the best economy on low-pressure steam and which are equipped with a special valve (Fig. 1) for admitting high-pressure steam to the low-pressure header automatically. This machine will not carry any load noncondensing, and will be very inefficient on high-pressure steam. It may be used where the condensing facilities are reliable, and when high-pressure may be considered an emergency condition.

(2) Turbines designed to give the best economy when operated low-pressure, and arranged to admit high-pressure steam through separate nozzles (Fig 2). This machine will give fairly good efficiency on high-pressure steam, will carry some load noncondensing, and some overload mixed pressure. It will carry its full rated load mixed pressure when there is insufficient low-pressure steam, or should the vacuum drop below that for which it was designed. This class should be used where it is intended to operate a large proportion of the time on low-pressure, or in installations where the boilers will blow when the engine is shut down, or where there is liability of the vacuum occasionally dropping off. These machines will continue to use all the low-pressure steam available when operating mixed pressure.

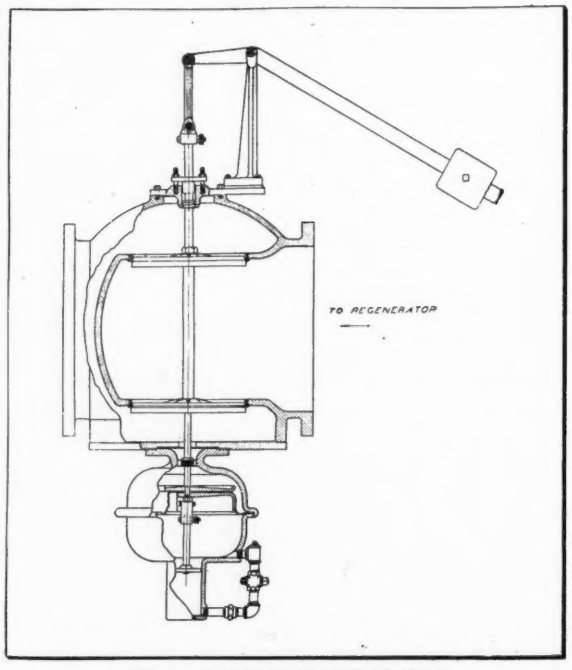


FIG. 4. FLOW REGULATING VALVE

(3) Turbines designed to give good efficiency at high pressure, and also arranged to carry load on low-pressure steam (Fig. 3). Machines of this class should be used when it is intended to operate continuously, or nearly so, on mixed-pressure, and where there is a limited amount of low-pressure steam which would otherwise go to waste. In this machine the admission of high-pressure steam will decrease the quantity of low-pressure steam that will enter. This means that, should the machine have to operate mixed pressure on account of low vacuum, the amount of low-pressure steam will be automatically reduced and a greater amount of high-pressure steam will be required.

Such machines are a compromise between a low-pressure and a high-pressure turbine. If designed to carry full load when operating either way, they cannot be made to give an efficiency as high as that obtainable on turbines primarily built for either high

or low-pressure operation. These machines can be designed to give a good efficiency and carry full load high-pressure, or carry about half load low-pressure at fair efficiency.

In the mixed-pressure turbine, the speed governor will automatically open the low-pressure valve with a decrease in speed, or a falling off in the supply of steam. By a special pressure actuated device, the low-pressure valve may be made to close and the high-pressure valves open automatically with decreasing supply of low-pressure steam.

In nearly every low-pressure, and in the majority of mixed-pressure installations, the best operating conditions and highest efficiency are secured by allowing the speed governor to control the low-pressure valve. This allows the vacuum to extend back to the engine supplying the steam during periods of operation when there is insufficient steam for the turbine.

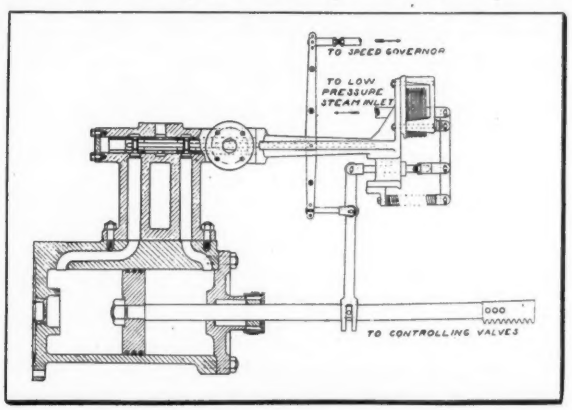


FIG. 5. DEVICE FOR AUTOMATICALLY OPENING AND CLOSING HIGH-PRESSURE VALVES WITH VARIATIONS IN SUPPLY OF LOW-PRESSURE STEAM

In certain installations it is not feasible to operate in this matter for one or both of the following reasons: First, inability to maintain air-tight joints in the piping between the engine and turbine, or in the engine itself. (In this case the vacuum on the condenser would be affected by the indrawing air.) Second, the back pressure on the engine at times being reduced below atmosphere, as in reversing rolling mill or hoisting engines. In installations of this nature, a valve can readily be installed in the low-pressure pipe to prevent automatically the vacuum from extending back, thereby maintaining a pressure above atmosphere on the piping and engine. Figure 4 shows a valve for this purpose. This valve has been given the name of "flow regulating valve."

When it is desired to maintain a fixed load on a mixed-pressure turbine, with varying quantities of low-pressure steam, this can be accomplished by a pressure actuated device arranged to open automatically high-pressure valves with a decreasing quantity of low-pressure steam. Figure 5 shows a simple arrangement which has been placed on several machines in commercial operation and has maintained a steady load under extreme conditions.

The Steam Regenerator

THE idea of storing heat is quite old. The action of the steam regenerator is based on the principle that the difference between the temperature of the steam available at a given time, and the temperature of the steam at a somewhat reduced pressure, may still be used to do work.

There are many different designs of steam regenerators, nearly all of which consist of a chamber containing a quantity of water, and so arranged that a large surface is exposed to the entering steam. Some time will be required to heat the water in the regenerator, and this time element must be taken into consideration in all cases. This means that where the supply of excess steam lasts for very short intervals, it cannot be expected that the water will be heated up to the temperature corresponding to steam pressure.

A regenerator will generate steam only when the pressure in the chamber is lower than the steam pressure corresponding to the temperature of the water in the generator. For example, if the water has a temperature of 212 deg. F. corresponding to 14.7 lb. absolute pressure, as soon as the pressure in the regenerator is reduced below this, a part of the water will be given off as steam, taking heat from the mass of water until its temperature is reduced to the steam temperature at lower-pressure.

Regenerator Capacity

THE capacity of a regenerator, or the amount of steam which it will give, depends on the quantity of water and also on the temperature range through which it may be operated. This means that a given quantity of steam may be stored and regained in a regenerator of smaller size and therefore of lower cost if the temperature range can be increased. In order to increase the temperature range, it is necessary either to raise the upper pressure limit or lower the low pressure limit, or both. The accompanying table gives approximately the theoretical amount of steam that can be regenerated.

This means that 1000 lb. of water at 19 lb. absolute and 225 deg. F. will give off about 62 lb. of steam if the pressure is reduced to 5 lb. For intermediate ranges take the sum of the amounts for each pound drop. For example, 997 lb. of water at 18 lb. absolute and 22.4 deg. F. will regenerate 13.2 lb. of steam if the pressure is reduced to 14 lb. For approximate results, to find the number of pounds of water to regenerate 1 lb. of steam, divide the average latent heat by the temperature drop. The curves of Fig. 6 make it possible to estimate quickly the size of re-

AMOUNT OF STEAM REGENERATED

Steam pressure, pounds absolute	Steam temp., Fah. degrees	Drop, degrees Fah.	Latent heat B. t. u.	Pounds water	Pounds regenerated
19	225.2		956.3		
		2.8		1000.0	2.9
18	222.4		958.3		
		3.0		997.1	3.1
17	219.4		960.5		
		3.1		994.0	3.2
16	216.3		962.7		
		3.3		990.8	3.4
15	213.0		956.0		
		3.4		987.4	3.5
14	209.6		967.4		
		3.7		983.9	3.7
13	205.9		970.0		
		3.9		980.2	3.9
12	202.0		972.8		
		4.2		976.3	4.2
11	197.8		975.8		
		4.6		972.1	4.6
10	193.2		979.0		
		4.9		969.5	4.9
9	188.3		982.4		
		5.4		962.6	5.2
8	182.9		986.2		
		6.0		957.4	5.8
7	176.9		990.5		
		6.8		951.6	6.5
6	170.1		995.2		
		7.8		945.1	7.4
5	162.3	...	1000.7	.....	...
				Total.....	62.3

generator necessary under any given conditions. Example: If the water can be heated to the temperature corresponding to 17 lb. absolute, and if steam may be extracted down to 10 lb. absolute follow the horizontal line 17 until it intersects the 10-lb. final pressure line, and directly below this find that 38 lb. of water are required for each pound of steam regenerated. It

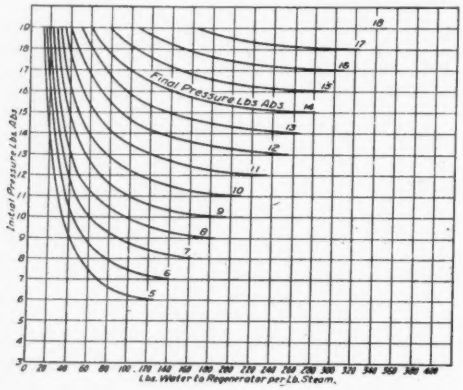


FIG. 6. CURVES SHOWING POUNDS OF WATER IN REGENERATOR PER POUND OF STEAM GENERATED, WHEN WORKING BETWEEN VARIOUS INITIAL AND FINAL PRESSURES

must be remembered that with the same valve opening, a steam turbine will take less steam and therefore carry less load as the pressure drops below that for which it is designed.

In order to secure the best economy, a regenerator is necessary in any low or mixed-pressure turbine installations where the supply of low-pressure steam is intermittent, and where, during periods of supply, there will be more steam than is required to carry the load on the turbine. By intermittent is meant frequently interrupted, similar to the exhaust from a reversing rolling mill or hoisting engine.

Limitations of Pressure Range

FROM the table it is obvious that the greater the pressure range, the smaller the regenerator required to regenerate a given weight of steam. The upper pressure is fixed by the back pressure which may be

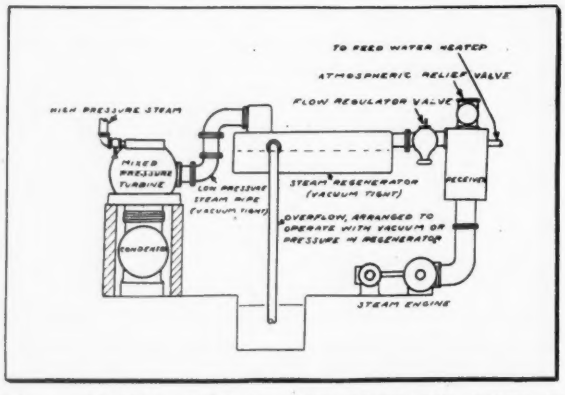


FIG. 7. DIAGRAM SHOWING FLOW REGULATOR VALVE INSTALLED BETWEEN ENGINE AND REGENERATOR

put on the engine supplying the low-pressure steam. In order to have the low-pressure limit below atmospheric pressure, it is necessary that the regenerator and piping be tight so that air cannot be drawn in.

Flow Regulating Valve

IN order that the regenerator may have the benefits of a wide pressure range, it is necessary that the flow regulating valve be installed between the engine and the regenerator. It will open automatically only when the engine is in operation. Should this valve be placed between the regenerator and the turbine, it will effectually prevent vacuum from extending back to the regenerator, thereby greatly decreasing its regenerating capacity.

The same argument applies against the method of control, in which the low-pressure valve is made to close automatically with decreasing supply of low-pressure steam.

Experience in commercial practice has shown that with few exceptions, the flow regulating valve is necessary only in installations where the supply of low-pressure steam is intermittent or fluctuating. For these reasons this valve should be independent of the turbine, so that it may be installed between the engine and the regenerator. When the valve is so installed, the regenerator as well as the piping between this valve and the turbine must be designed and installed so as to operate under vacuum. An additional reason for installing the flow-regulator valve between the engine and regenerator is to prevent the regenerator from filling with air during periods when the supply of low-pressure steam is interrupted.

Figure 7 shows diagrammatically the arrangement described. The overflow from the regenerator must be so arranged that it will prevent the water rising above a fixed point under any condition of operation. This can be accomplished either by a barometric column, as indicated in the diagram, or, if this is impracticable, by a vacuum trap. When the engine is shut down for some time, the piping between it and the flow regulating valve will fill with air, and it is undesirable that this air be driven into the turbine as it would affect the vacuum. An excellent arrangement, therefore, is to provide an opening in the receiver, which can be piped to a feed water heater; this connection carrying off most, if not all, of the air, and conserving the heat in the steam. Arrangements similar to this are operating commercially.

An article in London Engineering, March 22, 1912, on "Waste-Heat Accumulators," cites several installations where power has been secured at a low rate by the use of low-pressure turbines. It is also stated that the accumulators or regenerators may be made to work satisfactorily if the pressure falls below atmosphere, and that in such cases the flow regulating valve would have to be placed between the engine and the regenerator.—General Electric Review.

(To be continued.)

IN A PAPER before the recent Congress of Refrigeration in Chicago, C. H. Stevens gave the records from a number of electrically operated refrigeration plants showing the power consumption, which averages as follows:—For fur storage, at temperatures of 30 to 15 deg. F., 0.51 kw.-yr. per cubic foot of space; for packers of meat, at temperatures of from 40 to 35 deg F., 1.41 kw.-yr. per cubic foot; for provision dealers, at temperatures of 40 to 20 deg., 1.43 kw-yr.; for wholesale meat dealers, at temperatures of about 20 deg., 1.66 kw.-yr. per cubic foot; for retail meat dealers, at temperatures of about 36 deg., 3.73 kw.-yr. per cubic foot, and for small provision dealers, at temperatures of about 35 deg., 6.8 kw.-yr. per cubic foot.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PRACTICAL ELECTRICAL ENGINEERING

Types and Characteristics of Direct-Current Generators and Motors, Including Series, Shunt, Compound and Over-Compound, and Differential Windings

By Norman G. Meade

SERIES-wound generators, formerly so extensively used for arc lighting, have become obsolete; but series-wound motors have many applications and the latter machines only will be considered.

In series-wound motors, the field coils are connected as shown in Fig. 1 and the current is the same in the armature and field windings.

When running without load a series-wound motor speeds up until it takes just enough current to make up for internal losses; as the armature speed increases, the current rapidly decreases owing to the rising counter-electromotive force. As the field and armature windings are in series relation, the flux is necessarily decreased, so that the armature must still increase in speed to generate its counter-electromotive force which at no load nearly equals the impressed electromotive force. At no load the current is small and the speed excessively high, in some cases high enough to injure the machine, consequently the load should never be thrown off entirely with the current on, without applying some means of breaking the motor.

Counter-electromotive force decreases slightly with increase in load, increasing the field flux with correspondingly increased torque and decreased speed.

In some makes of series-wound motors the field magnets are wound with enough turns so that the magnetic circuit becomes fully saturated at light load, producing a fairly even field over a wide range of load, which reduces the variation of speed with variation of load.

Series-wound, as well as all other types of direct-current motors, are reversed by reversing the direction of the current through either the field winding or the armature, and control is secured by introducing resistance in series with the armature.

Among the more important characteristics of a series-wound motor may be mentioned: It is sparkless; it has a strong starting torque and will race if allowed to run free; its speed will vary over a wide range with changes of load. For service where the speed is constantly under the control of an operator and where frequent reversals are necessary, as exemplified in electric cranes, hoists, elevators, turntables, etc., the series-wound motor is especially adapted.

Shunt-wound Machines

SHUNT-wound generators and motors are alike in construction, the connections being shown in Fig. 2. The field winding consists of many turns of fine wire which receives but a small percentage of the total current applied to or generated by the machine. As a motor, the shunt machine is notable for its speed-regulating qualities and is especially adapted to the continuous driving of machinery of all kinds which does not have widely fluctuating loads.

By introducing resistance in series with the shunt-field winding a shunt motor's speed may be varied over a considerable range which is limited by the fact that sparking will occur if the field be too much weakened.

One side of the field winding is connected directly to one armature terminal, but the other side has a connection to the line switch so that when the latter

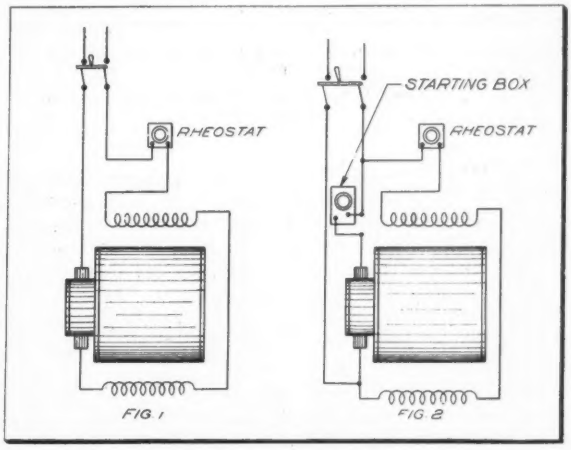


FIG. 1. CONNECTIONS OF SERIES-WOUND MOTOR
FIG. 2. CONNECTIONS OF A SHUNT-WOUND MOTOR OR GENERATOR

is closed the field coils receive current before the armature does; if this were not so arranged, owing to the low resistance of the armature it would practically short-circuit the line and blow the fuses or trip the circuit breaker.

Shunt-wound generators are best adapted to fairly constant loads such as electric lighting, but do not possess the inherent regulating qualities that make them suitable for widely varying loads such as elevators and street railroads; such generators are found mostly in small plants and are not made in large units.

Compound-wound Machines

AS with shunt-wound machines both compound-wound generators and motors are similar in construction and combine to a considerable extent the characteristics of both series and shunt machines. They are provided with a shunt winding in every re-

spect similar to a shunt machine, and a compound winding corresponding to the series winding of the series machine. It is usual to place what is known as a series shunt across the terminals of the series winding to carry a portion of the current so that the effectiveness of the compounding may be varied to a considerable extent. The connections of a compound machine are shown in Fig. 3. When 2 or more compound-wound generators are operated in parallel, it is customary to make an equalizer connection, as shown in the cut, which connects to the terminal on each machine where the armature and series field leads join. By this means the compound windings, as well

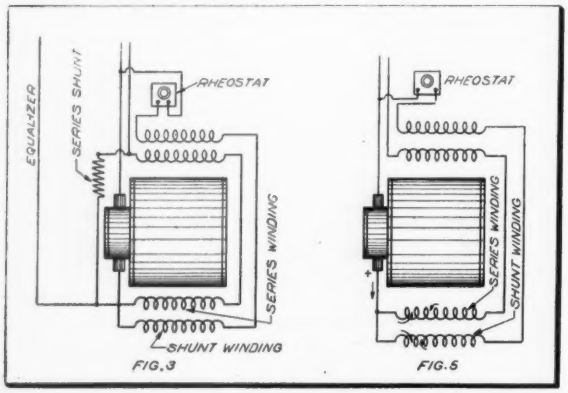


FIG. 3. CONNECTIONS OF A COMPOUND-WOUND MOTOR OR GENERATOR

FIG. 5. CONNECTIONS OF A DIFFERENTIALLY-WOUND GENERATOR

as the armatures of the various machines, are connected in multiple, which serves to prevent reversal of current through the series winding of any generator whose voltage became less than that of the line.

On a motor, the object of a compound winding is to gain closer speed regulation where there is a widely or suddenly fluctuating load. As the demand for current increases with each increase of load, the magnetic flux due to the compound winding is materially increased, thus eliminating the tendency of the motor to slow down as would be the case with a shunt-wound motor under severe operating conditions. When the load is suddenly released, the shunt winding maintains sufficient field to prevent any tendency to racing.

A modification of the compound-wound motor is known as the mill type and is equipped with both a series and a shunt winding, the former predominating, the shunt winding being used merely to prevent undue racing when load is thrown off.

Compound-wound motors find wide use on reciprocating machinery of all kinds especially in machine shop practice on planers, slotters, etc., where the load varies from the full cutting load to that if a mere friction load several times a minute. Motors of this type also have a speed regulation within certain limits by means of field resistance.

In providing a compound winding for a generator, the object is to maintain a uniform voltage under widely varying conditions of load or overload. It is evident that with increased current demands the current flowing through the series winding will increase also, thus increasing the field flux and consequently the voltage to compensate for the natural drop under severe operating conditions.

Over-compounding is quite generally employed; by over-compounding is meant the proportioning of the series winding in such a manner that the full load terminal voltage is greater than that at no load. This is for the purpose of compensating for the drop in line potential which occurs with increased load and serves to maintain rated voltage on apparatus located at the end of the line.

By reference to the diagram, Fig. 4, this will be made clearer. The straight center line denotes the voltage characteristics of a machine designed with compounding coil, to give rated terminal voltage under all conditions of load; the lower diagonal line represents in an exaggerated manner what would take place under similar conditions with a simple shunt machine. The upper diagonal represents the increase in voltage with increase in load in an over-compounded generator.

Auxiliary pole generators and motors are now quite extensively used and consist essentially of a regular type of multipolar machine with the addition of small auxiliary poles between the main poles; the windings on these auxiliary poles are connected in series with the armature, and the series windings, on machines where the latter are employed. The object of the auxiliary poles is to maintain a fixed commutating field regardless of load conditions, thus maintaining sparkless commutation and overcoming the effects of field distortion caused by armature reaction.

Auxiliary-pole motors are used principally for variable-speed service and can be regulated through a wide range of speed by means of field resistance.

Differentially-wound Machines

DIFFERENTIALLY-wound generators find their principal use in the lighting of railroad trains and automobiles. They are similar in construction to an ordinary compound-wound machine with the exception that one winding opposes the other, that is, the current in one winding flows in a direction opposite to that in the other, as shown in Fig. 5.

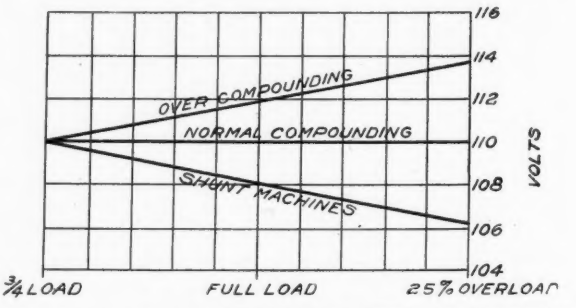


FIG. 4. VOLTAGE CHARACTERISTICS OF SHUNT AND COMPOUND GENERATORS

It is readily apparent that generators operating from the running gear of cars or automobiles must vary greatly in speed and were there no means for regulation, the voltage would vary wildly. Differential generators are designed to give practically a uniform voltage between the maximum and minimum limits of the automatic cutout. As the speed increases the voltage has a tendency to rise, thus increasing the current passing through the series winding, the latter opposes the shunt winding, thus tending to reduce the field flux, thereby maintaining a uniform electromotive force at all speeds.

CIRCUIT BREAKER ALARMS

Arrangements for Blowing Whistles and Ringing Bells when Circuit Breakers Open

By W. E. Chandler

THERE are several electric light and power and street railway power stations in New England where there is only one man in the engine and generator room. He is the watch engineer and his work is to keep an eye on the fire room and see that steam is kept up to pressure, tend the engines in operation during his shift and keep them oiled, also tend the switchboard and if, as sometimes happens, a condenser, feed pump, or any of the other auxiliaries give out, he must make repairs as soon as possible and keep the juice on the line at the same time for there is no one thing that will bring the wrath of the officials down on his luckless head more quickly than to interrupt the movement of the cars or put the town in darkness, be the time ever so short.

It frequently happens that Mr. Engineer is downstairs packing a feed pump or condenser, making some other repair, or perhaps he is in the boiler room giving the one fireman a helping hand to keep the steam pressure up to the proper point during a hard pull, when a circuit breaker opens and he does not hear it and not being on the floor with the board of course does not see it. Pretty soon the telephone bell rings and some such conversation as this takes place.

Telephone (car despatcher, division superintendent or lamp inspector). Hello. Power Station?

Engineer.—Yes. What's wanted?

Telephone.—Well, what is the matter down there? Are you asleep? There is no juice on such and such a line.

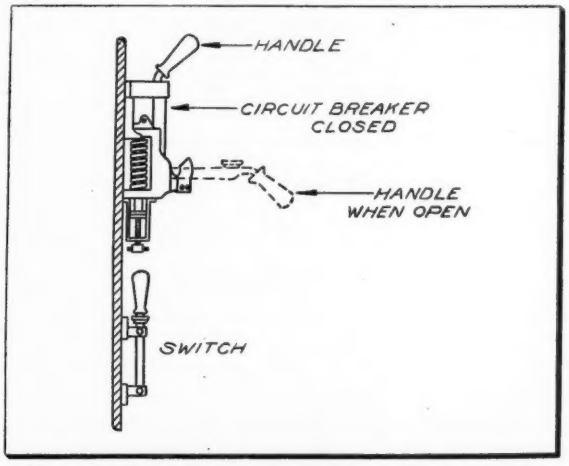


FIG. 1. SIDE VIEW OF SWITCHBOARD PANEL SHOWING CIRCUIT BREAKER AND SWITCH

Engineer.—Wait a second. (Looks at board, closes breaker and returns to telephone). Hello. I was busy downstairs and didn't hear that breaker open. Are you all OK now?

Telephone.—Yes, but for the love of Mike get onto yourself and keep those breakers in. The service is all balled up now on account of your not tending to business.

Later on, the chief engineer will probably call him up and give him fits for letting the breaker remain open more than ½ min. Perhaps it has happened before and the chief has received a letter from the superintendent of motive power or general manager, calling him down for keeping such a man in charge of a shift, and the chief in turn will give the poor fellow a going over for not attending to business better. But one thing is sure: The company will not, except in rare cases, furnish an oiler for the watch engineer; nor will it fall over itself in haste to furnish material to make an alarm to notify the engineer when a circuit breaker is open, no matter what part of the station he may be in.

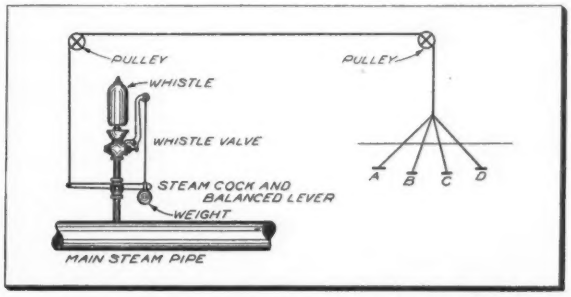


FIG. 2. STEAM WHISTLE USED TO GIVE ALARM

It has been my good fortune, however, to work with a chief on one or two occasions who had head enough on his shoulders to invent a sure and simple means of notifying the whole neighborhood when a circuit breaker was out, and I will attempt to describe some of them.

In a small country street railway power station in Massachusetts there were only one fireman and one engineer on each shift of 12 hr. each. The plant consisted of 3 horizontal-tubular boilers and 2 20 by 48-in. simple condensing engines, each belted to a 225-kw., 550-v. railway generator. There was only one independent jet condenser for the 2 engines and 2 6 by 4 by 7½-in. duplex feed pumps to supply the boilers with water; one or the other of these was constantly under repair, or if the unusual happened and they both held together for a week the condenser was sure to give out, and as a result the engineers never had any chance to get lonesome or put on a surplus of fat due to lack of exercise.

The switchboard was one of the simplest possible, consisting of 2 panels containing 1 main switch and circuit breaker for each machine, and 2 more panels each containing a line switch and breaker. These breakers were of a type now obsolete or nearly so. They had handles which projected at an angle of about 45 deg. from the vertical face of the board (see Fig. 1), and when it was open it was down in the position shown by dotted lines.

The main steam pipe was inside the engine room and in a line almost exactly opposite the center of the switchboard was a plug where at one time a 1½-in. pipe had lead out to radiators and used to warm the former chief's office, but this had been arranged differently,so the present chief obtained a small whistle and steam cock with a lever handle and by means of a few reduced couplings and other fittings, connected it to the main steam pipe and on the steam cock he placed a new line which was counterbalanced, as shown in Fig. 2.

One end of this lever was hitched to the lever of the whistle valve, while to the other was fastened a wire curtain cord, such as is used on street car curtains. This cord was then carried to the ceiling of the engine room and through small pulleys, led across to a point directly over the switchboard; from the main cord individual cords led to the handle of each circuit breaker, as shown at A, B, C, D. When one of these breakers opened, the handle had weight enough

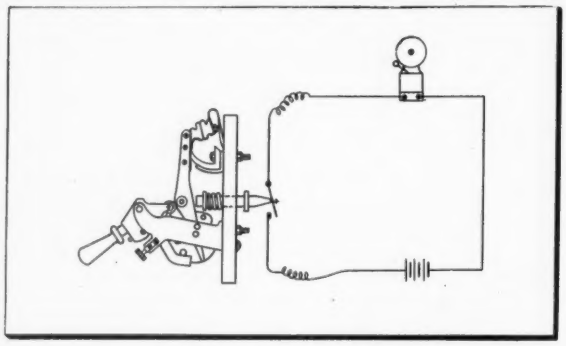


FIG. 3. WIRING OF ALARM BELL

to pull the long side of the balanced lever up, the opposite end opened the whistle valve and the steam cock being opened at the same time, of course the whistle gave notice that the board needed attention. This arrangement worked successfully for over 7 yr., until this station was finally turned into a substation and the engines stopped.

The next arrangement I ran across for giving notice of an open circuit was in one of the finest stations of its kind and size in the State of Massachusetts when it was built. Like the first arrangement described, it was attached to the arm of the circuit breaker and consisted of a small electric bell, such as is used for telephone extension alarms and was operated by wet batteries wired in the usual manner except that instead of a push-button being cut into the circuit a spring contact was mounted on the board and the opposite sides of the circuit connected to it as shown in Fig. 3. Of course when the breaker opened the arm falling allowed that part of the switch connected to the wire leading to the bell (and which was a flat spring) to touch the contact connected with the battery; this completed the circuit and caused the bell to ring until the breaker was replaced, when the bell circuit would open automatically. The principal trouble with this arrangement was that the battery ran out just when it was least expected to and when the station crew was the busiest. But after a couple of failures the chief arranged fixed dates for recharging it and no further trouble was experienced.

The next circuit breaker alarm I worked with was in a modern turbine driven electric light and power station. The circuit breakers in this station were all oil breakers and had very small distances to travel when they opened, and owing to general appearance it was not desirable to attach an alarm to the handles of the breakers on the front of the board, so after studying the matter a short time the electrician thought out and put into use the following plan. These breakers were all for 3-phase circuits and extended back from the board about 20 in. and were each supported at the back end by a single post of 1-in. pipe rising from a floor flange up through a ring at the back of the tank to a few inches above the top of the switch. A lock nut in each side of the ring held that end of the switch rigidly in place while the other end was fastened to the switchboard. The electrician placed a wooden plug in the top of each support and strung a pair of wires along on top of them. These wires were led into a vibrator in series with a 6-in. gong; this vibrator got its current from the exciter buses at 110 volts, d.c. On one of these wires was fastened a strip of spring copper which laid across the other wire but did not make a contact with it until the breaker was opened. From this copper strip a connection was made by means of a small tension spring and short cord to the back end of the breaker arm, each breaker having its own individual strip and connection and as long as the breakers remained in the bell circuit, being open of course, there was no alarm, but if any of the breakers opened the weight of the lever and contacts drew the copper strip down onto the wire parallel with the one to which it was fastened and completed the bell circuit and caused the bell to ring, and if the breaker was opened on purpose and was to be left open for any length of time it was only necessary to place a bit of common paper between the copper strip and the second wire in such a way that when the breaker was put in again the paper would fall out of the way and the alarm was ready for business again.

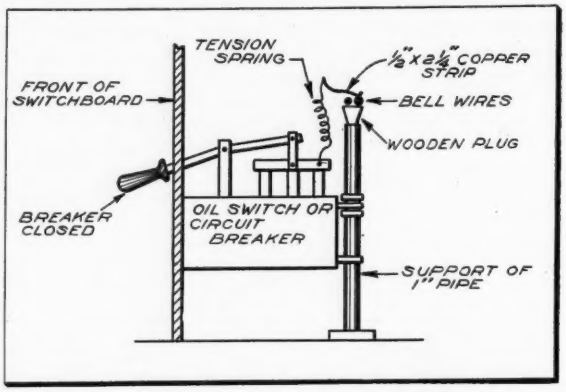


FIG. 4. ALARM WIRING FOR OIL CIRCUIT BREAKER

These devices can be applied with little variation to various parts of the mill or power plant, such as water tanks, sumps, etc., and the time and labor they will save will repay the cost of installation many times over.

IN THE CARE OF internal combustion engines, ethyl alcohol has been proved to be of great assistance. Used regularly twice a week, it becomes a remover and preventer of carbon, and for producing a nonfreezing mixture in the jacket, it is the best medium so far discovered. In using it as a carbon remover, the best practice is to pour a half to a full wineglassful into each cylinder at night on shutting down, and let it remain until morning. To start up the engine, open the throttle wide and blow out the loosened carbon, which will have been made soft and flaky by the action of the alcohol. In using for a nonfreezing solution, it is found that when mixed with water, a mixture of 20 per cent alcohol will not freeze above 10 deg. F., 30 deg. above zero F., 35 per cent above 10 below zero, 40 per cent above 20 below zero, and 50 per cent above 35 below zero. The alcohol best fitted is not wood alcohol, but what is known to the trade as pyro alcohol, which is the ordinary alcohol, rendered unfit for drinking.

POWERFUL ELECTRIC LOCOMOTIVES

THE New York Central & Hudson River R. R. Co. has recently ordered 6 additional powerful passenger electric locomotives from the General Electric Co. for terminal service out of New York City. Early in the year 10 of the most powerful type ever built were ordered from this company for the same service, weighing 100 tons each. While the new machines are of the same type and construction, they are somewhat heavier, weighing 110 tons, and due to recent advance in locomotive design, have materially increased capacity for continuous service.

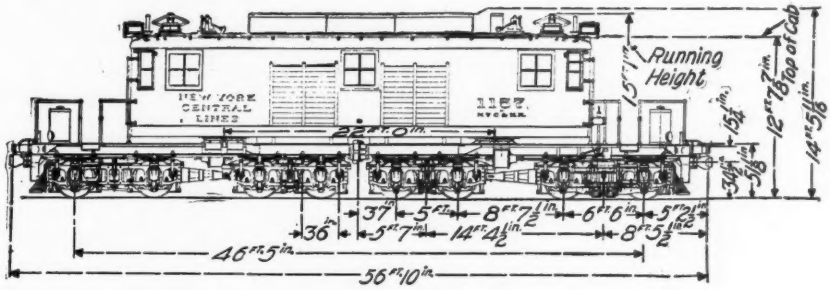
Growth in traffic and corresponding larger and heavier train units since the introduction of electric locomotives has been notable. In 1906, 35 600-volt, direct-current, passenger, electric locomotives were built by the General Electric Co. and introduced in the Terminal. These machines are of the 115-ton type, designed with sufficient tractive effort to operate 535-ton gross weight trains at 60 miles an hour in the regular terminal service, as were the 12 locomotives put into service in 1908.

The 10 100-ton electric locomotives ordered the fore part of this year are each equipped with 8 bipolar, gearless motors, all the weight of the machine being carried on motor-driven axles. These engines are designed for pulling the heavy limited trains and will exert sufficient tractive effort to operate 800-ton trains in continual service between the New York Central Terminal station and Harmon. They are capable of operating a 1000-ton train in emergency service or a train of the same gross weight on level tangent track continuously, at 60 miles an hour, or an 800-ton train at 65 miles an hour.

But the weight of the trains which are being hauled out of the Terminal is ever increasing steadily, and some of the more important trains now weigh over 1000 tons. It has therefore been deemed desirable to have engines for the maximum service with very great continuous capacity, ample overload and high momentary rating. The new locomotives are able to exert practically the same tractive effort continuously that the previous 10 locomotives can for one hour.

All the axles are driving axles, and the 8 motors are of the same general design as the motors on all the previous locomotives, and are provided with ample forced air ventilation.

The motors are electrically connected permanently in parallel in pairs, and the pairs can be connected in 3 combinations; viz., series, series-parallel and parallel. They are insulated for 1200 volts, so that if at any future time it should be desired to operate the locomotive on this voltage, the pairs of motors could be changed from parallel to series connections and the same speeds and control combinations obtained as on 600 volts.



OUTLINE OF NEW YORK CENTRAL ELECTRIC LOCOMOTIVES

NEON LAMPS

IN the manufacture of liquid air by the process of G. Claude, of Paris, the so-called "rare gases" of the atmosphere are separated out. In a lecture on "Liquid Air and Its Uses," delivered at the time of the Chicago Refrigeration Congress, Mr. Claude said that neon is, perhaps, the most interesting of these gases. It is present in the air in perhaps one part in 66,000. It is produced as a by-product in the liquid-air oxygen apparatus of the lecturer. Neon, compared with atmospheric air, is an excellent conductor of electricity. Mr. Claude used the comparison that where 1000 volts are required for a given electrical transmission in air 13 volts suffice in the case of neon. This gave the speaker the idea of constructing with the aid of neon luminous tubes similar to those produced by D. McFarlan Moore, who used nitrogen. The light from these tubes is a bright red, but the inventor says that they have the advantage of much greater efficiency than the Moore nitrogen tubes, the relative consumption of electricity being given as about 0.6 to 1.7. Furthermore, the light is said to be of excellent quality from the point of view of visual acuity, contributing to sharpness of vision.

But the intense red of the light would hardly permit the use of these tubes for general illumination without correction to introduce some violet or blue. It happens that whereas the light of neon contains no blue, that of the mercury-vapor tube contains too much. Mr. Claude has made corrective tubes containing a little mercury. These tubes, when used in conjunction with the neon tubes, produce what seems to be a very satisfactory illumination as far as color effect is concerned. Without color correction, the tubes may be used in decorative lighting or as advertising novelties.—Electrical World.

IN ANSWERING THE QUESTION as to how to take rope from a coil without kinking, the Plymouth Cordage Company gives the following directions: Place the coil on its head with the inner end of the rope at the bottom, then draw out the end anti-clockwise and throw the rope as it comes out so that it will fall in the same direction as that taken during the unwinding. Where storage space is limited, it may be necessary to draw from the outer end of the rope.—Mill Supplies

"HELP! WATER!"

The Plain Story of a Feed Pump That Went "Bronco," a Thirsty Boiler and Why

By E. C. Bowman

ALL was peace and harmony. The entire plant was co-operating in friendly activity, and over all rested the quiet spirit of the perfectly attuned machine. To be sure nothing was really quiet, for to voice the spirit of content in a power plant there must arise in blended chorus the deep diapason of the furnace roar, the steady throb of the pumps, the middle tone of the whirring turbine, the 'cello of the humming generators and the steady rhythm of hook and block and dashpot, the triangle and kettledrums of the orchestra of industry.

As things turned out this matinee concert developed into a real and vivacious vaudeville, hence we may pause to get our characters in mind and visualize the scene somewhat in detail.

And first the characters: The Chief, assured that all was well, sitting by the window in the sunshine of belated spring with the semirelaxation which sunshine induces and thought straying from the Sandy McDougal letter which he was reading, first to the arrangement of beans, tomatoes and sweet corn soon to be planted in the garden outside and then to the best arrangement and system of piping for the new heating plant to be installed this summer; but with ear always alive like a sleeping hound's for a note of warning or discord in the harmony. A man full of resource, quick in emergency, good-natured and able to see a joke even though the laugh be on himself, and appreciative of horse sense in others.

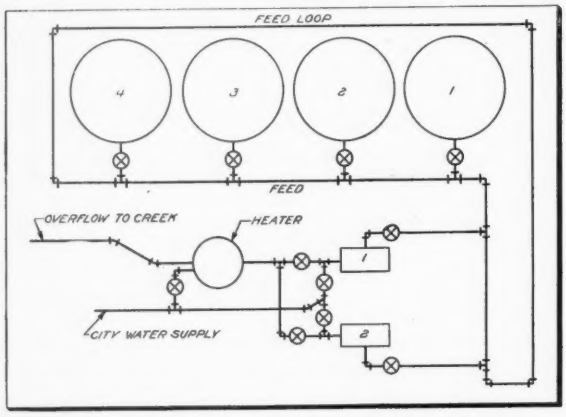


DIAGRAM OF THE PUMP AND FEED LINE CONNECTIONS

In this quiet spell, the Chief was "assisting" the oiler, the most recent comer in the plant and nicknamed Tallow, by letting him alone as he made the rounds of engine, generator, motor-generator set, low-pressure turbine and switchboard, bestowing a squirt of oil here, a wipe and rub there, and an inquisitive pat on a possibly warm bearing, watching the dancing needles of the meters and at intervals giving a twist to the rheostat for a needlessly fine adjustment of voltage as the street railway load varied slightly. The Chief smiled appreciatively as he noted the oiler's pride in keeping everything up to the mark and proving his ability to "handle her just as well as Eph," the second engineer.

Where was Eph? Eph, the faithful, with profound respect for the Chief's orders, ever trying to run things "jest as the Chief would 'a done it."

Even the best of equipment will wear, and out where the burners were licking with long tongues of flame the heat-hungry tubes, Eph was superintending an emergency rescue, with "Slice," the stoker, as working member of the crew. Slice was given the name, apparently to keep up tradition, for how could a slice bar be used in this 4-boiler plant where the fuel came in pipes to the 300-hp. Stirling boilers, and was "stoked" by opening or closing a gas cock? But Slice was having real troubles just now, for the supply pipe which fed 2 of the 16 burners of No. 2 boiler by running under the brick floor and turning up in the ash pit had rusted off just at the floor and the pit was not over commodious for removing the short piece remaining in the floor ell, that also being rusted in. No. 1 and Nos. 3 and 4 were merrily sizzling at the pop valves, and between these and the struggle with the pipe, it was no wonder that the language which came in grunts and muffled bursts from No. 2 ashpit past the wedged-in body of Slice was heated and at times sulphurous, and that requests for ——— me —nother chisel —nd —teen —nch —tilson carried excess baggage of words not common in the parlor when the children are present. Eph's part was to hand in tools through the fire door, to encourage Slice in continuing the good work by optimistic prophecy of the near completion of the task, and to offer suggestions, such as seem so plausible to the man on the outside and are so soothing (?) to the one who has just skinned a finger or blacked a thumb nail trying, a moment before, to do the very thing suggested.

And so are accounted for our characters except the "ensemble," the MacHinery Family, which included the Westinghouse generating sets, 2 200-kw., 2 180-kw. engine units and a 500-kw. low-pressure turbine, a 500-kw. General Electric motor-generator, the 4 Stirling 300-hp. boilers, a couple of Platt boiler feed pumps and Pittsburgh open heater. With the relations of this family, except the feed lines, this story has no concern. It is enough that the station was well regulated and the bonds sufficient to hold all members in unity and agreement.

For the boiler feed, the provision was as shown in the diagram. Purified condensation from the turbine was delivered to the open heater and from this the pump in service drew its supply. The make-up from the city mains came in near the overflow to the creek so that ordinarily the overflow pipe carried any floating scum and cool water, and city water could also be fed, as shown, direct to the pump suctions in emergency. Just now No. 2 was pumping.

Deeper peace and greater harmony now encompassed, for Slice had at last conquered the stubborn stub end and his irregular vocal obligato had ceased. Eph was bringing up supplies in the form of a new piece of pipe and a union when of a sudden came a burst of discord.

Down went Eph's load with a bang as he jumped for No. 2 pump which had been quietly feeding the

boiler and now was bucking madly back and forth, hitting the head at every jump. Slice, backing out for a rest was just at the point where he wondered which arm would come out first easiest, and, thinking Eph was throwing in the pipe and union yelled: "Quit throwin' that stuff in here, darn yer. I'm comin' out for a spell." But his protest was lost and the continued racket which sounded to him as if the feed pipe over his back were splitting to fragments induced a frantic effort to hasten with consequent sundry bumps and bruises to head, ears and shoulders. Free at last, he saw Eph, faithful to the Chief's instructions, "Never start a cold pump to pumping without warming her up," trying to get No. 1 into action and anxiously watching the gage glasses on Nos. 3 and 4 where the water was steadily falling.

Slice started suggesting in his turn, meantime feeling of ears and elbows to find just how much damage he had suffered. "Why don't yer shut No. 2 down an' get No. 1 busy?" But Eph, trying to think what the Chief would do, cut him short. "Oh! shut down yourself and stand by No. 2 and make her do all you can 'til I get this thing warm." And he hurried as much as he dared, to bring No. 1 slowly into service.

By this time Nos. 3 and 4 boilers were whistling loudly for Help! Water! and Eph, hoping to mend matters turned the cold water with the city pressure behind it into No. 1's suction, but with no effect.

We have forgotten one important factor, Adonijab. He answered impartially to the names Don, Jab or Kid according as the Chief, Eph or Slice called. Jab was at the age when school palls and work calls, and the power plant called him continually—much stronger than spading the garden, splitting the kindling or even the game of 3-ole cat down the alley. Hence, Jab was usually somewhere around, tolerated when errands were to be run and scolded when he got in the way, or opened a wrong valve in his desire to have a hand in the work.

At the first bang of the pump, Jab had appeared from nowhere in particular, and was excitedly feeling around pump and heater pipes for a possible leak, with an eye on the pressure and water gages, ready to run at any sign of danger.

Meanwhile, the water had gone down and Eph's anxiety had correspondingly risen. The Chief, hearing the racket, had decided to let Eph fix it if he could, wisely thinking that the responsibility and the satisfaction of going it alone would be a good experience, and feeling that Eph would call for help when he needed it.

But Eph had got to his wits' end, and from the continued noise, the Chief judged it was time to take a hand, so just as Eph called "Jab you get ——" the Chief appeared, and seeing the last rim of water disappearing in the glass, jumped for the pumps, and excitedly repeated about the same series of operations that Eph had gone through, with the same results. It was evidently a case of loose valve with No. 2, but why didn't No. 1 produce?

There was one peculiar thing. No 1 boiler was still carrying her water line as high as the S-C. Regulator would let her, and was faithful to family tradition, while Nos. 3 and 4 were down close to the danger point of low water.

"Here, Eph, you tend No. 2 and, Slice, you shut off feed from No. 1. Maybe there's a stoppage between 1 and 3, though those end ones ought to get feed around the loop connection. Anyway, try it and perhaps 3 and 4 will get more feed."

But the result was a prompt dropping of the water line in No. 1 without appreciable change in the condition of 3 and 4.

"They'll bust up sure. Boilers always do when the water gets low. The newspapers always says low water blowed 'em up." This from the oiler who had followed the Chief out and stood in Napoleonic contemplation of the feverish activity of the others.

And the Chief, "Here, Tallow, you get back inside on your own job and keep things oiled, and if I send word to shut down, you do it p. d. q., understand?" And Tallow went.

Bang! Bang! No. 2 pump was going lickety-split at top speed and No. 1 a good second and still the water in Nos. 3 and 4 showed no gain. No. 1 was on the last ¼ in. of the glass.

"Where in thunder is all that water going? Well, we've got to keep No. 1 on and pull 3 and 4," said the Chief, and Slice got into action at once. Slowly the water in No. 1 crept up and the flames under 3 and 4 flickered out. And the Chief scratched his head and looked reproachfully at those rebellious members of his household.

Meanwhile Jab, to whom nobody had paid any attention, had been alternately poking around the pipes and watching the Chief, and in the pause, he broke out: "Say, what's this heater heatin' backwards for? The creek water's hot an' the pump's cold; somethin's unhitched."

The Chief looked around, walked over and felt of the pipes, and an expression between relief and disgust spread over his face. "Well, of all the darn fools! Here's this kid found what had all of us fussing around to guess it. Shut that No. 2 suction and we'll stop pumping the whole city water works back through No. 2 into the creek. And then turn No. 1 suction on the heater, and close off No. 2 all round. Take her apart and fix that discharge valve that's stuck wide open."

In about 2 minutes the water in No. 1 boiler was coming up fast; and as the lowest gage cocks on 3 and 4 showed quite moist, the feed was turned into them and soon the boiler end of the plant was working as quietly as ever.

During the mixup things had been happening in the engine room. The city pressure, always low, had been so reduced by the draft in the endeavor to increase the creek water level, that there was not enough for the low-pressure turbine glands. The condenser got a slug of air, and the whole unit went out of business. So as the Chief entered, Tallow yelled, "I didn't shut her down, Chief. She just died on her own account."

Fortunately the a.c. load was light, and by the help of the motor-generator it was kept going, but the street car motormen and conductors enjoyed (?) a half hour of rest explaining to passengers and would-be passengers that they "didn't know anything about it why current was off." And they "couldn't tell when the cars would start again," which of course was entirely satisfactory to men missing engagements, and women late to important card parties.

When things were in normal condition once more, and the pleasant composite symphony in full swing, the Chief hunted up Jab, who was condoling with Slice over the missing cuticle and the swollen ear, and a triangular conference ensued as follows:

Jab. "Wha'd yer jump out so for? The pump wasn't anyw'ers near you. An' anyway, if the thing busted you'd be safer in the firebox than out in the room."

Slice. "Well, I was mostly out anyway. An' that noise in the feed line sounded like the whole pesky boiler was started loose. An' if things are goin' to fly, I like to see 'em comin' and have a chance to dodge, even if I don't miss 'em."

The Chief. "'Twas too bad you got banged up so. Better let the rest of the job go until tomorrow. We don't need No. 2 for a couple of days yet. Say, Jab, when did you feel that heater inlet getting hot?"

Jab. "Why right away when No. 1 got the city water."

The Chief. "Well, why didn't you say something about it?"

Jab. "Why I thought Eph ought to know what to do, and besides No. 2 pump was hot then."

The Chief. "Well, when did the pump get cold?"

Jab. "Oh! Just after you came out and turned on the city feed."

The Chief. "Why didn't you say so?"

Jab, with mischief in his eye. "Well, I thought you surely would know what to do, and I expected to see the boilers fill up. And when you acted flustered an' the boilers didn't fill, I reckoned p'raps you didn't really know where the water was goin' either."

The Chief, smiling. "Kid, you're a little too smart, but you seem to have a nose for trouble and sense to locate it, and I guess we can use you. You get some overalls and a jumper and come around tomorrow and you can start by finishing that gas pipe job."

Slice. "But, Chief, what'll I do?"

The Chief. "Well, you tell Don how to fix up the troubles he finds and help him get out of what he gets into. Don't teach him too much or he'll be running the whole plant before we're ready to quit."

HOW HEAT GETS THROUGH THE BOILER PLATE

DOWN in South Africa they are not content to take things for granted simply because someone said so once on a time. They want to know whether things are really so or not, and a live association of engineers, called the Transvaal Institute, has a habit of getting papers on original research which contain new and important matter. One is a report on some experiments which for a primary object had to determine the economy of heating feed water by live steam, and the direct investigation was to determine the rate at which heat was transmitted through boiler plates under different conditions.

We have assumed that hot water fed into a boiler which will move rapidly and begin to boil quickly would take up more heat than cold water, and that the water-tube boiler, which has a high rate of circulation, is a more efficient type than the tubular with slower circulation. Our engineering friends in South Africa put a question mark after this statement and wanted to know, "Is it? or Isn't it? and if it is, Why so? and if it isn't, Why not?"

One of their number, Sydney Bilbrough, went at the matter experimentally and constructed a small boiler having underneath it an oil burner. This boiler was tested with clean plates and also with a thin lining of scale; into the water in the boiler was stuck a thermometer and the rise in temperature in a given time with a given weight of water determined the rate of transmission of heat; after the water came to the boiling point it vaporized and passed away and the amount of water boiled away in a given time, multiplied by its latent heat gave also the amount of heat carried through the shell in that time. The experiments were not on a tremendously big scale. The boiler was 9.25 in. in diameter by 7 in. high, but the action was proved so definitely as to leave little doubt of the correctness of the experiments.

Without going into details of the experiments, which would not interest us just now, it was found that there was practically no difference in the rate of transmission through the plate whether the water was hot or cold; that with a coating of scale 3/64 in. thick there was a serious loss in the heat, but that whether with or without scale the transmission of heat through the plate was the same for all practical purposes whether the water were hot or cold.

Now we are confronted by 2 opposing sets of experiments, both of which are vouched for and apparently correct. How are we to reconcile them, or where is the joker? In South Africa they have proved that the rate of heat transmission through a boiler plate from the hot gases is independent of the circulation of the water, of any layer of gas bubbles on the plate, or of any hot film of water next to the plate; that there is no gain in efficiency by live steam feed heating and that the effect of a layer of hard scale 3/64 in. thick is to reduce the capacity of the boiler by 20 per cent. The rate of evaporation used was 7.5 lb. of water to the square foot of heating surface per hour, which is reasonably common practice.

But in experiments carried out by John T. Nicholson, in England, and by the United States Geological Survey, here, it has been absolutely proved beyond question that in England and in America a high speed of circulation of the water in the boiler does give greatly increased power to absorb heat, and Mr. Nicholson states flatly that the amount of heat that can be transmitted is almost directly proportional to the speed of the gases, so that if we hustle the gases along over the heating surfaces and on the other side hustle the water along, we can reduce the area of heating surface in steam boilers to 0.5, 0.25 or even 0.1 of what we commonly employ, and he asserts that our boiler practice has to be absolutely overturned, that we must use drafts of from 10 to 20 in. of water gage induced by fans in order to get real economical working; that we must use a counter-current flow of gas and water and by so doing we may get the gas temperature to within 20 deg. of that of the entering feed. In other words, if we put water at 60 to 80 deg. direct into the boiler we can pull our chimney gas temperature down to 100 deg., "provided only high gas and water speeds are resorted to." This is to give us a boiler efficiency of over 95 per cent.

Furthermore, this increased evaporative efficiency of the heating surface will make it possible to line the furnace with firebrick so as to get a chamber similar to the reverberatory furnaces used in metal working, and there the combustion will be so perfect that any need for skilful firing is dispensed with. All that will be necessary is plenty of air and ample mixing space behind the bridgewall and yet we shall have entire absence of smoke.

Now, with such wide disagreement between what have been found to be reliable sources of information the question comes, Which one is right, or are they both wrong, or do heat units behave differently in South Africa from what they do in England? It seems to be a case of 2 against 1, for the general trend of Mr. Nicholson's conclusions agrees with that of the United States Geological Survey experimenters. We shall see what we shall see.

TAKING CARE OF BEARINGS

Adjusting Different Types of Connecting Rod Brasses and Bearings with Quarter Boxes

By J. C. Hawkins

THERE are numerous methods used by different engineers in keying up bearings, some of which are only guesswork and especially on the crank and wrist pin. All bearings must have a little clearance to allow for expansion as the bearing warms up and for lubrication, but it is often guesswork to know just how much is being allowed.

It is a good plan to calculate just how much the boxes will be tightened by 1 turn of the wedge bolt or driving the key ⅛ in. or the thickness of the lines taken out as in the marine type, Fig. 3. After several years' experience and study on the matter I have decided on the following method as being the most satisfactory to me and find it the only sure way when an engine must be kept in operation after keying up, whether the bearings are hot or not. It is much better to be sure before the start than to have to fight a hot pin or shut down and slack up on the wedge afterwards.

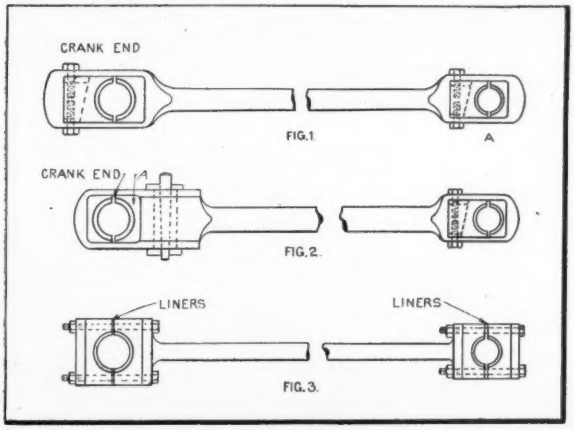


FIG. 1. CONNECTING ROD WITH BOTH ENDS WEDGE BOLT ADJUSTMENT

FIG. 2. WEDGE BOLT ON CROSS HEAD AND KEY, GIB AND STRAP ON CRANKPIN

FIG. 3. MARINE TYPE WITH BOLTED ENDS

Figure 1 shows a connecting rod from a high-speed engine; the wedge bears directly on the back of the box and is held by 2 cap screws; to tighten the box the top bolt is loosened and the bottom bolt screwed in, then the top bolt set up tight. The wedge in one make of high-speed engine has a taper of 10 deg. or 2⅛ in. in 1 ft. and this engine uses a 1 in. cap screw with 8 threads per inch. In drawing the wedge down 1 in. the brasses will be closed 2⅛÷12=0.177 in., one turn of the cap screw will give 0.177÷8=0.221 in. and one flat or 1/16 of a turn will give 0.0037 in. nearly. This is figured out for each bearing and the number either stamped on the brass or noted for further reference.

In keying up this type of bearing, if the pin is in good condition, I loosen the top cap screw and draw the wedge down tight, then slack back about 0.004 in. for an 8-in. pin and 0.003 in. for a 4-in. pin and others in proportion, depending on the condition of the pin, the speed and load. After the first trial one can usually tell just how much clearance will be required. The wrist pin is adjusted in the same manner as the crankpin but given about 0.001 in. less clearance.

In using the rod shown in Fig. 1 the cylinder clearance is not changed by the wearing of the brasses, but in some engines of this type the wedge is placed back of the other brass on the crank end, in which case wear will cause the rod to become longer, thereby reducing the head end clearance. This is equalized whenever necessary by placing shims of soft steel between the brass A and the end of the slot in the rod usually on the crank end as it is more accessible. There are several other styles of wedges used, some of which draw sidewise or use collar bolts, but all are adjusted the same as the one shown.

In Fig. 2 is shown another rod using gibs and key on the crank end and wedge and cap screw on the wrist pin. The wedge used in the crank end has a taper ⅜ in. in 1 ft.; as shown in Fig. 2 the back brass A sets against the end of the rod and is held by the strap. The gibs prevent the strap from speading and, in driving the key, the strap is drawn farther up on the rod as gib 1 bears on the strap only and gib 2 on the rod only.

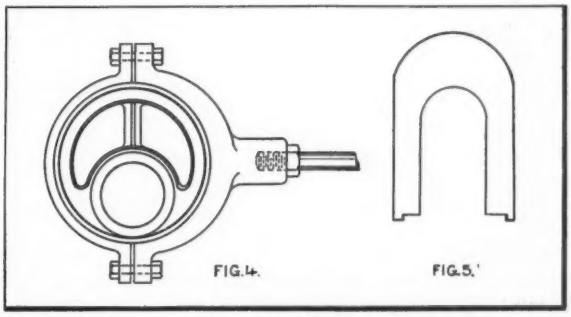


FIG. 4. ECCENTRIC STRAP ADJUSTMENT

FIG. 5. PROPER SHAPE OF LINER

Driving the wedge 1 in. will close the brasses 0.375÷12=0.0312 in. and ⅛ in. will close the brasses 0.0039 in. In keying up a bearing of this type, lay a rule or scale across the gibs and key and make a mark with a lead pencil; do not us a scriber because this leaves a new mark each time and is apt to be misleading, while the pencil mark will do as well and will wipe off. Then drive the key down tight and slack back to give the proper clearance as previously determined, which will vary with the different size pins.

The crosshead pin uses the wedge and cap screw and is adjusted as in Fig. 1. Wear on the back brasses in this type has no effect to change the length of the connecting rod and therefore will not change the clearance in the cylinder. When the key has been driven all the way down it is taken out and a ⅛ in. steel feather made to fit between the gibs and key. A soft hammer, either copper or lead, should be used in driving the key to prevent upsetting the ends.

In keying up I usually turn the crank to about the back center which point brings the wedges to the most accessible position. If the crank pin is out of round the keying up will be done on the largest diameter of the pin, but to accomplish this on the crosshead pin it would be necessary to have the crank at half stroke, which makes the top cap screw inaccessible.

Figure 3 shows the marine type which is used on engines of all sizes from the high-speed fan engine to the 5000-hp. main mill engine. Thin liners are used between the 2 boxes, and there should be several liners in a set, 1 or 2 thick ones and the rest made up of thin ones some of which should be 0.005 and 0.008 in. In this type the thickness of the liner removed determines the amount the boxes are set up.

To tighten the bearing, loosen the nuts on the bolts and take out 3 or 4 thin liners, being sure to have the same number on each side to keep the boxes square; then put in a piece of soft wire—fuse wire is good—on each side and draw up snug but not tight enough to spring the brasses. Then slack off, take the wire out and measure the thickness with calipers, or better yet, a micrometer, and put back enough of the liners to make up this thickness plus the clearance desired.

This method takes more time than to take out 1 or 2 liners and bolt up, but the results gained will overpay the trouble of getting the exact thickness required. These liners should be made with a slot from the bolt hole to the end as shown in Fig. 5 so that they can be taken out by merely loosening the bolts.

On some engines, especially the small vertical high-speed type, it is almost impossible to get at the crosshead brasses and in this case the pin has to be taken out and the crosshead blocked up. Then by turning the crank to the lower center the pin can be fitted in the brasses below the crosshead. After the bearing is fitted in this way it will cause no trouble.

In this type of rod the wear on the back brasses causes it to become shorter, which will decrease the crank end clearance in the cylinder. This is overcome by placing a steel shim or liner between the box and the end of the rod.

In taking up on the eccentric, Fig. 4, it is often impossible to use the methods given for marine rods because the castings are light and the distance between the bolts is long and the strap is easily sprung, so that drawing up tight on the soft wire will be misleading. I usually take out a thin liner, say 0.005 in., then after tightening up, disconnect the eccentric rod from the valve gear and try moving it sidewise and up and down. This will show how much clearance it has. The eccentric does not need to be very tight as the diameter is large and the load is light. It is quite often necessary to do a little guess work on the eccentric, being sure not to take out too much at one time.

In keying up the valve gear, the bearings are so small that very little clearance is required and at the same time the parts are light and an excessive amount in proportion to the size of the pin will do no harm; I usually set the brasses up tight then slack up a little.

In keying up the main bearing, Fig. 6, the wear is usually taken up by some form of a wedge, either one that pulls up or pushes down between the quarter box and frame. As this bearing is stationary it is adjusted while running and the wedge is drawn up or pushed down as the case may require, just enough to cause the bearing to run quiet and no more. Wear on the back quarter box will throw the shaft out of square with the center line of the cylinder which will cause the crank pin brasses to bind and wear one sided.

Modern engines have "spots" planed on the inside of the frame opposite the disk and paralleled with the center line of the cylinder. Caliper between one of these spots and the crank disk, then turn over until the same point on the disk comes opposite the other spot and caliper there; the difference, if any, will show whether the shaft is out of alignment or not.

If it is, take the wedge out of the main bearing quarter box and push the shaft and back quarter box ahead with a pinch bar if the engine is small; with a large engine put the crank on the center and admit a little steam through the bypass to the head of the cylinder which will move it very easily, then place a thin liner between the back quarter box and the frame.

Quarter boxes have to stand the thrust of the piston and therefore wear much faster than the bottom box which carries only the weight of the shaft and wheel, together with the crank, governor and armature. Any wear of the bottom box can be found by placing a level on the shaft which will show whether the main bearing is low or not. If very much, it should be raised and a thin liner placed under the bottom box. In nearly all modern engines the main bearing is so constructed that by raising the shaft an inch or two the bottom box can be taken out for examination.

In the center crank engine the wear on the back quarter boxes does not throw the shaft out of alignment with the crank but decreases the head end clearance, and in putting liners back of the quarter boxes care should be taken to get the same thickness back of both to keep them square. Spots are planed

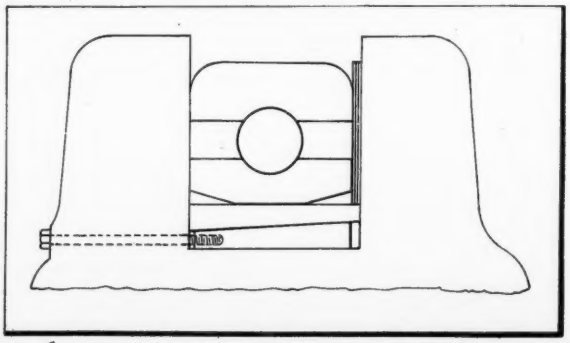


FIG. 6. SECTION OF MAIN BEARING AND QUARTER BOXES

parallel with the center line of the cylinder for the purpose of alignment as in the side crank engine. Some of the later improved engines have a wedge under the bottom box in the shaft bearings which is shown in Fig. 6, which allows the bottom box to be raised without the use of liners.

All engines of to-day are so constructed that the bearings may be flooded with oil, my way being to run a good stream on the crank, crosshead and shaft bearings, the used oil being drawn off, filtered and cooled and used over again, preferably from an overhead tank by the gravity system rather than an individual tank mounted on each engine.

On the eccentrics compression grease cups are used with No. 1 Keystone or similar grease unless the eccentrics are well enclosed; then oil can be used without throwing it on the wall and floor.

On the governor bearings and links and on the valve gear, grease is used exclusively, as it is cleaner, cheaper and requires less attention. I prefer the hand compression cups to the spring aompression wherever it is possible to use it, because when I give it a turn I know that the grease is going into the bearing; while many a hot bearing has been caused by a lump of wax in the grease or a particle of waste stopping up the hole in the bottom of the automatic grease cup. Also with the automatic cup the grease is liable to be fed too fast and much of it be wasted.

LETTERS DIRECT FROM THE PLANT

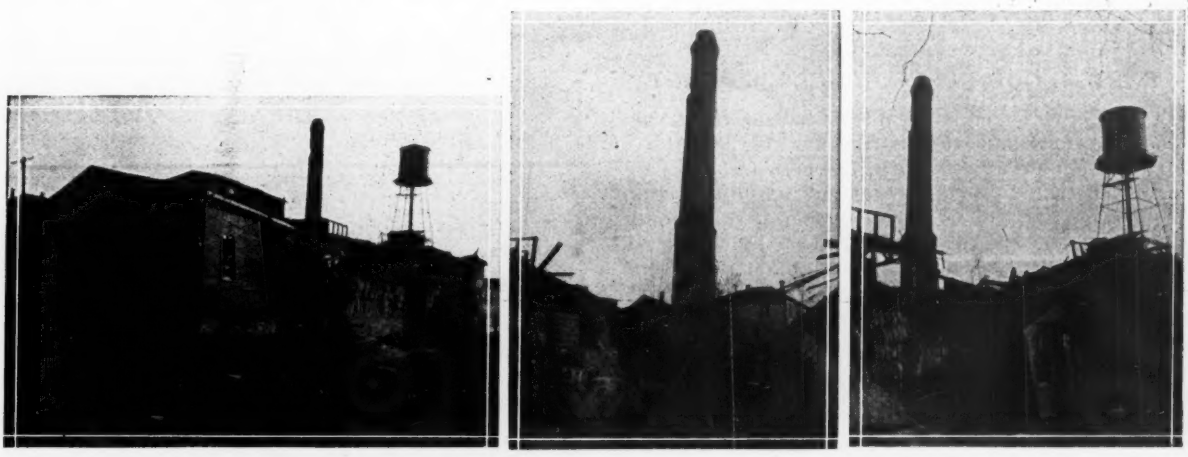
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

BOILER EXPLOSION AT FRANKLIN, OHIO

AT 5:30 p.m., Nov. 11, just after the employes had left the mill, the boiler in the rag mill of the Harding Paper Co., Franklin, Ohio, exploded with such force that it completely wrecked the mill building and did thousands of dollars damage to property within a radius of 4 blocks of the mill, blowing part of the boiler through a dwelling 500 ft. from the mill. Only one person was injured, the engineer of a Big 4 freight engine standing on the siding in front of the boiler room, who was cut by flying glass and bricks. The freight engine was disabled by a large timber crashing through the cab.

The boiler was an old return-tubular, 54 in. by 16 ft., with a shell made of 5/16-in. iron, double riveted lap joints. It had been in use about 25 yr. as a power boiler, but was lately changed to a heating boiler, connected to an open hot water system. The mystery is, why did the boiler explode with such awful force when connected to an open-tank system, when the expansion tank was only about 40 ft. above the boiler?

The wreck is so complete that nothing can be found to indicate the cause of the explosion; but as it was the first time the boiler had been fired up this season, and the explosion took place just 1 hr. and 15 min. after the fire was started, it looks as though the boiler was shut off from the system. The heads were both blown out, shearing the rivets and pulling every tube out. The shell was ripped in all directions, following the longitudinal seam a short distance, then tearing around a girth seam, then ripping into the solid plates, tearing them into pieces from 2 to 6 ft. square. The dome was torn completely off the shell. An examination of the tubes and shell showed them to be practically free from scale and corrosion, but the iron was badly crystallized. J. M. Davis.



VIEWS SHOWING DESTRUCTION OF MILL DUE TO BOILER EXPLOSION AT FRANKLIN, OHIO

NEGLECTED BOILER

ON taking charge of my present power plant job, I found one Atlas boiler, 66 in. by 16 ft., doing all the work in our light plant. She was new, and the only things in her favor were good water, and the half-night run system.

Boiler cleaning day came every 4 weeks. At midnight when the fires were dead, they would slightly open the engine valve and by morning she was dead, as far as steam went, but plenty of heat still existed and that cold air rushing under the boiler all night did not help long life. Well, the engineer cut his nap short next day, and gave the boiler a good scrubbing down, then the hose was stuck into the top manhole and cold water rushed in.

There was a small water system over the town, and about the time in the evening when you carried a wrench in your hands, watching manholes, for you knew if one blew out, all was dark for that night, the telephone would begin to ring. "When are you going to turn on the water?" Or, if it was a hot day, "When will the fans run?"

The owner was almost afraid to go up town on a hot day.

All of this rush and worry could have been averted by putting an old boiler into service. It was then rusting away, which is much more ruinous to the metal than when in use. Besides this, the rushing of Boiler No. 1 through the cooling and cleaning process was bound to have a bad effect upon it. Yet, this thing had gone on for several years with boiler No. 2 sitting idle. Work had been started several times to finish her up, and put her in service, but it remained for me to do the job. The owner had just put up a smokestack, when I came in upon the pay roll.

Boiler No. 2 was the old boiler, and had been moved and reset, the brick work all done except back arch. There was no piping on her, except a stub of a blowoff pipe, that I had a hard time getting out. On the main steam line was the old boiler's gate valve, hooked to a short steam line. I put in 2 new flues, finished up 8 new ones that were just pushed into place, built up the back arch, dug up dry pipe, pop valve, water column, put on new piping and valves, packed the manholes with some bow gaskets, scaled the boiler and made her top feed.

Now, the boss said that one of the wedges in the big gate valve on the new boiler was gone. We sent the remaining wedge to the foundry and had one made, which worked fine.

After I had filled the boiler with hot water, I got up 125 lb. steam on the new boiler and started my pump to feeding the old boiler. I gave her a good test; it took me 45 min. to pump up 160-lb. water pressure. My joints were all good; I had taken great care in making them. The first night I steamed up I made light and have been able to run the boiler each month, and give the new boiler a good rest and cleaning out.

The boiler is 54 in. by 16 ft., has 3½-in. flues, furnished steam for 12 by 12-in., high-speed engine, direct connected to 60-kw. generator for several years, was overloaded part of the run. One time they bagged the boiler at the rear end, but were able to drive it back. The smoke box ring is about eaten up on the bottom, but the shell is good; the insurance company gave us 125-lb. pressure, as she was a high-pressure boiler when new. C. H. Brough.

EXPERIENCE IN SECOND-CLASS PLANT

I TOOK the examination for a second class engineer's license and was informed by the inspector in a kindly manner that I lacked experience. He also suggested that I find a job taking charge of a third or operating a second class plant and after 6 months or a year of such work to come and see him again and then, no doubt, I should pass and obtain the second-class license. I had sense enough left to know the inspector knew my number so I changed my special giving me charge of a 500-hp. plant for a third, knowing that the only way to have charge of such a plant again was to work hard and get a first class engineer's license or leave the Bay State.

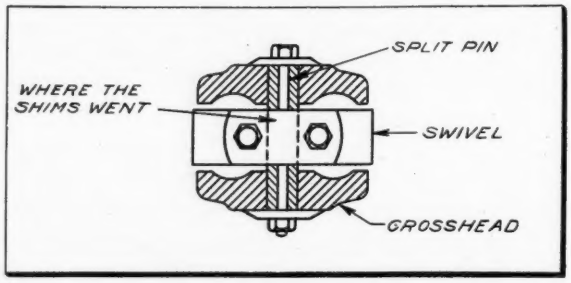
It was with regret that I bade farewell to my job where I could work all the week without soiling my overalls except in the seat, where I could read all the technical papers and books and fill my head with a lot of rules and formulas that did me no good because I did not have the practice to apply them. The only excitement I had was when the vacuum pump would lose a valve or spring. Indicating the engine twice a day and figuring the diagrams, making out a report of the input and output of the engineering department, which included wages, coal, waste, oil and water used, repairs made and the amount of kilowatt-hours, this was the extent of my work except going through a battery of boilers in the spring just before the insurance inspector came along and again during the fall, cleaning them. I kept a record of this on file but no one seemed to be interested in it besides myself.

Now, after 13 yr. of this I have got to go out and get some experience. Well, believe me, it hurts like thunder to do it. After breaking in my successor, who is a man with a nice new first class license with a big gold seal on it and his head full of the improvements he is going to make, I hiked up to the lime works and hired out as operating engineer.

This is a second class plant and consists of 2 5 by 16-ft. horizontal tubular boilers, an injector, duplex feed pump, one 12 by 14-in. Buckeye engine belt connected to a compound wound d.c. generator, one Atlas 10 by 12-in. belt connected to a series wound d.c. generator, one Class A Ingersoll-Rand air compressor.

The chief showed me around and told me my duties and that I was to make sure of keeping things running during my shift, as they had a record of no shutdowns for over 6 months and the engineers had to do all repair work.

It was evident that many repairs had been left for others to do from what I could see and hear in the engine and boiler rooms. I could also see that coal and oil were thought little of, and as the engine and boiler rooms were close to several lime kilns and stone crushers and everything was left wide open, dirt was held in contempt. I had spent all day talking to the chief and he had taught me a lot, but if I should meet him washed I don't believe I should recognize him.



SECTION OF CROSSHEAD

In regard to the need of repairs, the Buckeye engine pounded on the head end stroke so that the cylinder oil can would not stay on the valve chest. The chief said the trouble could not be remedied, as he had tried to equalize the lead and the engine had run away. I asked permission to shut her down for half an hour and then I equalized the compression regardless of the lead, set the cutoff valve so it would cut off steam when the piston had traveled about an inch with the governor weights at extreme out position, started her up and the big noise was gone; but there was a pound as the crank passed the center, so I flushed the crank with oil and as the pound continued I stopped her and stripped the wrist-pin brasses and found the key driven as far as it would go. I drove it out and put a shim in, drove it in again and tightened the set screws. I then removed the indicator pipes and with a piece of ¼-in. lead rod tried for clearance while the chief and superintendent turned her over by hand. She did not touch at either end, so the pipes were put back and we started her up. One would hardly know she was there by the noise she made. We were stopped about an hour, but the chief said it was worth the shutdown and just as soon as they got the new tunnel through we would put the air compressor in shape. "We have always had a machinist from the county seat do the tinkering on that, but now we'll do it ourselves," he said.

The compressor was used to keep 90 lb. pressure in a tank that supplied 2 rock drills about a mile and a half away. The riding cutoff was let out as far as it would go and the compressor had all it could do to keep the pressure up. The regulator did not have much to do while the drills were running. The noise she made was like the emergency being thrown on a train of Pullmans as the tail end of a stalled freight comes into view round a sharp curve and by the thump that followed when the piston changed its direction of travel one would think that the brakes failed to work. The chief said it was only the intake, but I thought that no air at atmospheric pressure could make that screech.

Early Sunday morning we pulled the back head off the air cylinder and found the intake valves warped so they would not seat. We put in new valves that had been ordered a year or so, then we removed the crosshead and swivel block. We found that while the pin fitted in both sides of the crosshead it did not fit in the swivel block, so I marked its running position and shimmed between the pin and swivel block, put it back in and tightened the pin up to the mark. We then started her up. I shortened the cutoff and pumped the pressure to 90 lb. I then followed the pipe to the quarry but found no leaks.

We started drilling in just 3 hr. from the time we stopped and the compression is running slow about ⅔ of the time. We don't have to shovel half as much coal now. I don't know much about air, so I'll ask your readers if a reheater at the end of the air line would not help matters. I'm getting the experience in large doses. J. H. A.

GOVERNOR TROUBLE

IN the Nov. 1 issue of Practical Engineer, on page 1059, I notice B. F. W. is having trouble with a Rites governor on an Ideal engine.

While I never had any such trouble on the only Ideal engine I ever ran with this type of governor, I have on a Chuse, in which the conditions are practically the same.

I do not know why he should touch the spring or weights unless he had reason to believe that in some manner the spring tension had been changed at the time when the engine's performance became unsatisfactory. My experience has been that the less you tinker with these governors the better you are off, outside the fact that you must take care of what little wear there is in the eccentric and strap and valve gear joints; a great deal of care must be used in doing this, so as not to get them too tight, for these governors are sensitive and the slightest sticking in the eccentric or joints will cause the engine to race badly. In this Chuse engine the brass bushings in which the governor arm pin works became worn so as to necessitate a new set.

When they were put in they fitted the pin a hair too tight and also in the casting which holds them, with the result that our voltage varied considerably. When we made them just the right fit, the engine never ran better.

I have also found that a too heavy grade of machine oil may be used on the eccentric and this will make it to stick enough to cause bad racing.

On our governor pin, to lubricate the bushings, we use a 3-oz. Lunkenheimer spring compression grease cup, filling it with No. 1 Arctic cup grease slightly thinned with good cylinder oil which must be thoroughly mixed in.

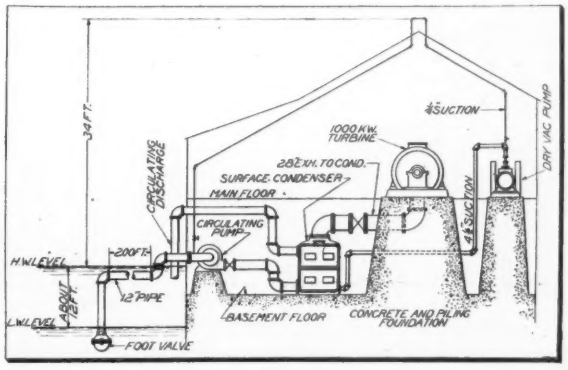
By this method we are sure the bushings are getting plenty of grease and that it is thin enough so they do not stick at all.

It may be that the grooves or oil-holes (depending on the type of bushings) have become filled with hard dirty grease, so that all parts are not thoroughly lubricated. I would take them out and make sure this is not the whole cause of his trouble. H. U. C.

PRIMING A CENTRIFUGAL PUMP

IN the plant where I am employed we had some trouble through our circulating pump's losing its water occasionally, at low tide. The pump is a 10-in. centrifugal, motor-driven, at 850 r.p.m., and at low tide has a suction lift of about 14 ft. and about 200 ft. of trail.

We primed it with a 1½-in. steam ejector, whose suction was connected to the top of the pump casing. Between us we thought out the scheme which is shown in the accompanying sketch. We drilled and tapped a hole in the top of the suction yoke of the circulating pump for ¾-in. pipe, screwed in a nipple and valve, and then run a line of ¾-in. pipe from there up through the roof to a height of 34 ft. above high water level, then down to the suction side of the dry vacuum pump, where a suitable connection with a valve was made.



ARRANGEMENT FOR PRIMING A CENTRIFUGAL PUMP

We generally have 28½ in. or more of vacuum, and that will maintain (theoretically) a column of water in the ¾-in. pipe over 32 ft. above the water level in the river. Now, if we have a column of water in the ¾-in. pipe 18 ft. high, above the pumps (maintained by the dry vacuum pump), have we a head of 18 ft. on the suction side of the circulator?

The arrangement did not seen to put any additional load on the air pump and we have not lost the circulating water since it has been in operation, over a year and a half. I would like to hear what some of your readers think of this.

There is a motor-driven hot well pump in a pit under the condenser, which is not shown in the sketch.

O. H. Peterson.

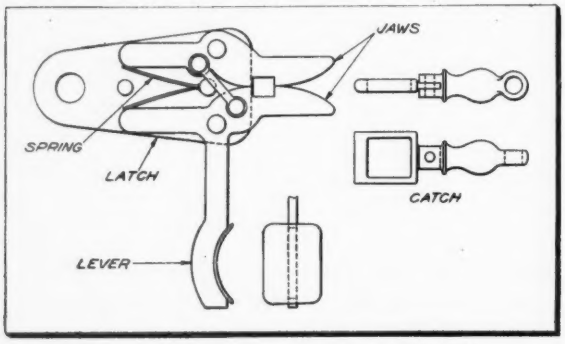
AN AQUATIC PROBLEM SOLVED

A COMPANY building a large mill on the banks of the Mississippi found it desirable under existing conditions to locate the boiler plant at a point where the surface grade at times is inundated. Instead of using piles to elevate the boiler room they built an enclosure of concrete walls, filled the enclosure with water-tamped sand to a point near the top and then covered it with a concrete slab. The footing of the walls was on comparatively good soil and the water-tamped sand effectively confined made a good filler. The boiler house walls were built on, and securely anchored to, the concrete walls. The boilers were suspended from beams which rested on columns at the sides of the boiler setting, and consequently the weight of the boilers was concentrated on the concrete under the columns. To reinforce the concrete at these points, 6-in. I-beams were buried transversely in it below the surface. W. O. Jones.

INDICATOR COUPLING

THE function of this indicator coupling is to facilitate the coupling and uncoupling of the indicator or reducing wheel cord to the crosshead of an engine while in motion, and will be found most convenient in connection with high-speed engines.

It is nearly impossible to place the loop of the cord over the pin attached to the crosshead (or as is sometimes used, a hook, attached to the end of the cord, which is hooked over some member attached to the crosshead) on engines running over 200 r.p.m., and



RECENTLY INVENTED INDICATOR COUPLING

this method is also inconvenient on slow speed engines.

With the improved indicator coupling shown here this becomes as easily done on the highest speed engine as though the engine were standing still. The latch is attached in any convenient manner to the crosshead of the engine, with the jaws facing the cylinder, while the catch is attached to the cord; then, to fasten the cord to the crosshead while the engine is in motion the catch is held between the fingers and brought forward toward the jaws in the path of the jaws while the engine is passing head end center; as the catch comes close enough, the jaws grab it and pull it out of the operator's fingers. To release the cord the operator lets it slide back and forth through the fingers of one hand while the forefinger of the other hand is held in such position that the lever of the latch comes in contact with it, while the crosshead is at its extreme backward motion; this opens up the jaws and releases the catch which is pulled back against the fingers of the other hand by the indicator spring.

This coupling does away with the detent motions and cord take-up devices now fitted to most modern indicators, as it performs all the functions of these attachments besides having an advantage over them in that it stops the reducing wheel while changing indicator cards, also by leaving the latch permanently fastened to the crosshead of the engine, indicator diagrams may be taken at any time without in any way interfering with the operation, or stopping the engine. The device is my own invention and I have had it patented. O. N. Bergman.

SOME INCONSISTENCIES

IN reading the description of the North Adams, Mass., plant, I note 2 statements that do not seem to be consistent. Evaporation per pound of coal is given as 10 lb. water, which at 14,000 B.t.u. per pound of coal means 10,000 B.t.u. given to the steam or an efficiency of 70 per cent, about as well as the average can do.

But they require 2.5 to 3 lb. of coal per kw.-hr.: that is 25 to 30 lb. of steam with an up-to-date turbine plant carrying 27.5 in. of vacuum. The 2 statements do not seem consistent as there are low-pressure turbines in this vicinity taking steam at atmospheric pressure and exhausting at 28 in. vacuum which put a kw.-hr. on the switchboard for 30 lb. of steam, making juice for street car lines.

On page 1059 H. G. R. wants to know the difference in the heating value of live and exhaust steam. The total heat received is:

Heating the feed water to 212 deg. F. 180 B.t.u. sensible heat;

Converting into steam 966 B.t.u. latent heat;

Raising steam to 100 lb. pressure 39 B.t.u.

If we run a pound of this steam through a noncondensing engine of any make the engine will turn the 39 B.t.u. into work and the steam will leave the engine carrying 180 + 966 B.t.u., of which 966 can be used in the heating coil if we allow the steam to condense. and the highest temperature one can get is 212 deg. On the other hand, if one passes steam at 100 lb. pressure through a reducing valve and the value is set to give atmospheric pressure, then the 39 B.t.u. are supposed to go to dry the steam, if wet, or to superheat it, if dry; but the chances are that the steam will lose some heat in forcing its way through the valve. and it would be folly to use live steam to heat with, if exhaust steam were available, unless you had to have a high temperature. We had some heating to do that could not be done with steam at atmospheric pressure. so we put a new and smaller safety valve on our boilers set to blow at 125 lb., thus enabling us to add 5 B.t.u. to the 39, which made it 44. Then we set our back pressure valve to open at 20 lb., which put a back pressure on our engine. But she carried the load with a little slamming, which we remedied by taking a little off the inside lap of the valve, thus preventing the compression from going above boiler pressure and causing her to run quiet.

Before we made the change we consulted the boiler inspector and the engine builder.

In looking over receiver's contribution on water columns I notice that he claims that the reason steam appears at the blowdown of a column when the valve is opened and the boiler is under pressure is because of the difference in the way the pipes point. I always thought it was because of the water flashing into steam when changed from a higher to a lower pressure.

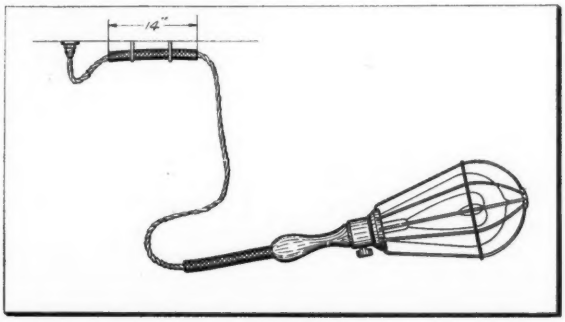
Alfred Griswold.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

To Prevent Breaking of Lamp Cord

I HAVE in my plant a large number of portable lamps suspended from receptacles above, which gave me no end of trouble by the reinforced cord twisting and breaking at the lamp holder and at receptacle above. No doubt a great many engineers have the same trouble.



ARRANGEMENT TO PREVENT BREAKING OF LAMP CORD

Take some ⅜-in., single-strip, Greenfield conduit, cut into 14-in. pieces, place one at the top with staple, thread the cord through so the strain comes on the conduit, drill handle for a screw pit and tape over the end around the cord.

I have made as many as 7 repairs in a single day of 10 hr. before using the method described. Now I have actually had just 4 repairs in 2 months.

A. D. Mead.

Loosening Unions; Piping Kinks

MR. HERBERT'S experience in regard to loosening a rusty union calls to mind several difficulties I have experienced with rusty unions and piping. I have found as a rule that those types of unions that are made up of one brass and one iron part will come loose more easily than the all-iron union with a narrow brass seat, because they do not rust in the thread. If the threads are given a coating of graphite and oil when coupling up, they will start much more easily when taken apart, as it is not so liable to rust.

In starting a tight one I hold a sledge hammer or the end of a heavy bar against one side and strike the opposite side with a hammer. This will tend to stretch the nut and will jar it loose, when it can be easily taken off with the wrench. This applies not only to unions but to any joint or fitting as well. The majority of pipe fitters use a white or red lead or a mixture of the two on the threads in making up a joint. This will make a tight joint and can be easily broken by tapping with a hammer, but if this will not hold I have found a mixture of litharge and glycerine to be good when it is impossible to get a tight joint with lead. Some steam fitters do not believe in pipe dope, but use only a little heavy oil on the thread, and claim that they can get a tighter joint this way than by using lead or pipe dope.

Litharge and glycerine sets quickly, and should not be used if it is desired to break the joint, as it will never come apart until the fitting is broken. An instance of this kind came up in our plant a short time ago. The receiver of the Holly system is located in a difficult place to get at, and a leak started in the connection to the riser. It was impossible to see just where it was while in place, so the receiver was disconnected and taken to the pipe shop. The trouble was found to be in a 2½-in. cast-iron nipple-ell screwed into the bottom of the receiver. The thread on the nipple end was 2¼ in. long and was so loose that it was screwed all the way in against the end of the thread.

We got it out all right, and after cleaning the scale and dirt out of the chamber, and looking for cracks or broken threads in the ell, etc., the threads were wrapped with twine and coated with a mixture of litharge and glycerine about as thick as soft putty. The fitting was then screwed in. We got it up within about ¾ of a turn quite easily, when the dope stuck while turning it with a 36-in. Stillson wrench. On account of the several other connections this ell had to be turned to look in a certain direction. We used a 5-ft. chain wrench with a piece of pipe on the handle, and could not start it either to tighten it up or to get it off, although we pulled hard enough to break the chain on the wrench. After working about 2 hr. trying to get it either off or on, we gave it up, and in order to connect up the receiver had to change all the other connections and turn the receiver around, then instead of screwing the riser direct into the ell, had to put in 2 45's to bring it square with the pipe, which made 2 extra joints. If the dope had not been so thick, that is, if more glycerine had been used, it would not have set quite so quickly.

Some steam fitters advise the use of a right and left coupling in place of a union for high pressure up to 2½-in. pipe. It is cheaper, and when properly made up, will be as tight as any coupling in the line. The right and left cannot be used in a close place, as the pipes must be spread apart far enough to start the coupling on; but there are places in which it is necessary to use a union that will probably never have to be taken apart, or at least at long intervals and that is the place where a coupling will do as well as the more expensive union. If the joint has to be broken often, however, a union is better. In using a right and left coupling the pipe fitter must be careful to get both ends tight. When cutting the threads the coupling should be screwed tight on each part and the number of threads counted on each piece. If it screws on more threads on one end than on the other, the coupling in making up the joint must be turned on the longer end until both ends are the same, and then when screwed up tight it will be tight on both ends. This is the only way to be sure that both ends are tight.

J. C. Hawkins.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

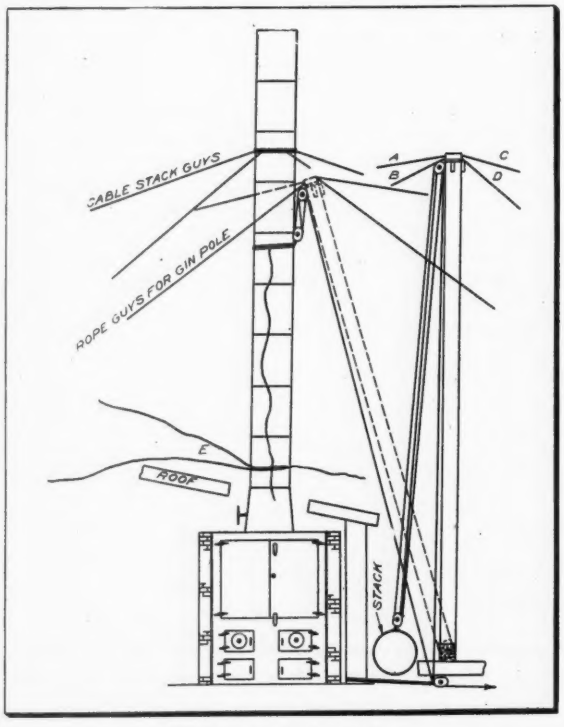
Erecting Boiler and Stack

WILL you advise me what course to pursue in erecting or installing a steel casing setting and for placing one horizontal tubular boiler over it? I have one to erect and I don't know which course to take. I thought once of blocking the boiler up to the right height, then fastening my columns, hangers and beams in position, then after I got the boiler in a level position, and hanger nuts tight, remove the blocking from under the boiler and slide the casing under.

Please give me your way of doing this kind of work.

2. Please tell me how you would raise a ginpole to remove an old smokestack or to raise a new stack.

J. L. R.



RAISING A STEEL STACK

A. As a general rule, boilers supported by any type of an arrangement whereby columns are used to sustain the weight instead of the setting itself, are to be erected in place and suspended by whatever means is provided, before any of the setting or steel casing is put in place.

Move the boiler onto the foundation and square it up with the location as closely as possible and jack it up to about the right height and rest on blocks for the time being.

Then erect the necessary columns and cross beams with whatever braces the design calls for, seeing that the columns have a good bearing on the foundation. Then by means of suitable braces, such as 4 by 4's of a height to suit, brace the columns and frame work in every direction so as to hold it rigid and at the same time not interfere with future operations.

These braces can extend to the building wall if near or can be well staked into the ground near by. Local conditions and good judgment will assist materially in this respect.

When thoroughly braced, the blocking may be removed if desired, although if not in the way of the workmen, it is usually considered in the interests of safety to leave supports of some kind under the boiler till the work is completed, simply as a matter of precaution.

When the boiler has been set level crossways and about an inch or so lower at the back end than the front, the casing can be put in place in accordance with the blueprints and plans furnished by the boiler manufacturer.

If you find that it is necessary to cut, trim, or chip the casing look the matter over carefully before doing so, and see if you have made any errors anywhere which would cause trouble. These casings are all put together by the manufacturer before shipment and should not require much, if any, cutting to make a good job.

2. In regard to ways and means of erecting a smokestack on a small boiler by means of a ginpole, and suggestions as to how to proceed, we are enclosing herewith a sketch showing method of rigging up a ginpole and hoisting stack, for a boiler located in a one-story building with a roof which will clear the boiler.

Of course, you will understand that it is not possible to give accurate information without knowing definitely what local conditions demand. The illustration, however, is perhaps applicable to more jobs than any other would be, therefore we are sending it, and trust that you will find it of assistance.

A large cedar pole, such as used by telephone companies, makes an excellent ginpole, on account of its comparative lightness, which is quite an item. If such a pole is not available, use whatever is at hand, even if it be necessary to splice together 2 8 by 8 timbers of a length sufficient to make a pole the required height.

The pole should be high enough to reach up about ¾ the height of the stack when the latter is in the highest position. (Such as would be required to hoist above a hole in the roof, as shown, or over a wall or other obstruction.)

It is a good plan to place a cross beam at the bottom of the pole about 5 or 6 ft. long, braced to the upright, and the ends resting on planks or block-

ing, as shown. This prevents any tendency of the pole to twist, and provides a good base for the pole to swing on which is clearly shown in the full and dotted lines.

Now as to a scheme to raise the pole, let us suppose that there is a building to the left of the boiler house in the sketch, say about 3 stories high, and better still, suppose that it has a flat roof.

By placing the bottom end of the pole against the boiler room wall, and the top pointing away from the building, a gang of men on the factory roof (or in the third story where the ropes can be passed through windows) can raise the pole nicely by guy ropes A and B, after the end of the pole has been raised as high as possible from the ground by means of blocking, braces, or pike poles (if handy).

Suppose that such a building is not handy. Then raise the top of the pole up on the roof and then still further, by means of blocking or pike poles, with the base, of course, pointing directly away from the building. By working the base up towards the building the pole can soon be raised by a gang of men on the ground, or by a wench, or by a team of horses.

After the pole has been raised to an upright position, and stayed by the guys, the base can be pried over to place by bars and guys adjusted from time to time as required. So much for the scheme of raising.

Having decided which is the best method of raising the pole, then proceed to get the rigging in place. Get the stack in place alongside of the building as suggested in full lines. Usually large stacks are shipped in 2 sections or more, to be riveted together at place of erection. A much better job can be made by bolting the sections together with a dozen or so bolts of the proper size, after which the rivets can be easily driven in place. When the joint is finished, paint the rivet heads and joints with asphaltum paint and it will add considerably to the life of the stack.

Arrange to set the ginpole about as suggested by the full lines, with the guy ropes A, B, C and D, extending in such a manner that they will permit of the stack being raised between guys A and B. Another good idea is to have a small block and falls as a part of these guys, especially C and D, which will greatly facilitate letting the pole over to the final position. If suitable falls are not available, see that a good snubbing post is provided, and several turns around this will serve very well.

For the main hoist, use not less than an inch rope if new or nearly so. Larger is better. Be sure that it is all whole and not cut or weakened in any way. The pulleys should be about 6 in. in diameter and not less than 2 to each block; 3 would be better, especially for the top one.

The pulley at the bottom should be about in line with the down-haul rope, but attached to something solid, such as an eyebolt through the building wall, or a rope end around a timber across the doorway, etc., after which it can be lead in any direction to whatever means is provided for hoisting.

In making the hitch around the stack, make it in such a manner that, after the stack is in place, by pulling on the loose rope hanging beside the stack, the hitch can be undone from the roof.

Next attach the steel cables which are furnished by the manufacturer for guying the stack. Coil these up and lash them to the base of the stack before hoisting and it will prevent them from getting tangled in the hoisting ropes. They can be lashed by the small guy ropes at E, which are necessary to guide the base of the stack around possible obstructions and to guide into place.

When satisfied that all has been made fast and that you have made the hitch on the stack about ⅔ the way from the bottom so that it will stand nearly upright, and that you have plenty of rope to hoist with above all obstructions, clear away all obstructions.

It might be well to mention here to spike a few 2-in. strips on the side of the pole near the top so as to keep the ropes from dropping down the pole.

Then hoist the pole by whatever means the suggestions will permit, and set it as suggested by the full lines. Make the guys snug and hoist the stack. Ease it along the ground with boards or small plank (but not bars) so that the hoisting rope will be nearly vertical at all times, taking care to thread the top of the stack through the guy ropes of the ginpole as the stack rises.

When the stack is clear of the ground, by means of the ropes E, hold it vertical while the ropes C and D are slacked off so that the pole will swing over towards the building and bring the stack over the hole in the roof, and consequently over the stack base on the boiler setting, after which slack back gently on the hoisting rope and lower the stack into place on the setting.

Take off the ropes E and attach the guy cables of the stack to whatever has been provided to hold them, meanwhile plumbing the stack.

Having the stack securely fastened, slack up on the ropes A and B, pulling in on the ropes C and D till the ginpole leans away from the building when it can be lowered to the ground by the hoisting rope, after which pull on the rope hanging beside the stack which will release the hitch and the stack is in place. Clear away the wreck. Geo. W. Wallace.

Pressure on Step Bearing

I AM in charge of 2 Curtis vertical turbines of 14,000 kw. capacity steam pressure 175 lb. and vacuum at about half load 28 in. of vacuum.

Now, with an oil pressure at the step-bearing pump of 750 lb. the pressure at the step bearing is 750 lb. When the oil pressure at the pump is raised to 1200 lb. per sq. in. the pressure at the step bearing remains 750 lb.

If, when the oil pressure was 750 at the pump and the pressure was 750 at the step bearing also, then there was no resistance to the flow of oil. It seems to me that, as the pressure of oil at pump or on inlet side of baffler increases, in order to keep the pressure uniform on the outlet side, the resistance of baffler should increase also. But this is not the case because the baffler is the same length whether the pressure is 750 or 1200 lb. at pump.

Any explanation you may give will be highly appreciated.

This same turbine has a 10-in. steam pipe. There used to be a valve in this steam pipe that would shut off the steam automatically in case we lost our vacuum, and of course prevent a steam pressure in the condenser. They took this valve out and connected the condenser with a 36-in. exhaust pipe. An automatic back-pressure valve in this pipe will open when the pressure in the condenser exceeds 3 lb. gage.

Of course if we lost our vacuum the turbine would run noncondensing until such time as we could cut the other turbine in.

Now what is the idea of a 36-in. exhaust pipe when the steam pipe is only 10 in.? Steam pressure is 175 lb. and vacuum at normal load about 28 in. F. L.

A. When no oil is flowing through the system the baffle offers no resistance, or if just a small quantity is flowing, an inappreciable amount.

Until the lifting pressure of 750 is reached, the pressure throughout the system is the same. Perhaps a little oil does flow but this is due to the imperfections of the blocks' surfaces, which imperfections always exist, especially after the machine has been running a little while. Your machine uses, I judge, about 16 to 18 gal. per min. It is reasonable to expect that 10 per cent or more of this amount might pass through the baffle without exciting resistance in the baffle.

With 750 lb. pressure in the system, the step tends to rise a minute amount, thereby allowing the passage of a little oil. Instantly the pressure under the step is reduced, for the flow from the pump is momentarily accelerated, and this flow, which is for the instant fast, meets great resistance in the baffle which in turn cuts down the pressure and consequently the flow to the step. Of course, the pressure need decrease but an ounce or two below the lifting pressure before the blocks are together again. As long as the pump pressure stops at, or slightly above, the lifting pressure, this procedure occurs again and again—and the slight pressure drop is too small to be noted on a gage designed for high pressure. When the pump pressure is high enough, the flow is great enough to keep the blocks permanently apart.

At 175-lb. gage pressure, and 100 deg. superheat (which I presume you use), the volume of steam is 2.81 cu. ft. per lb.; at 3 lb. gage pressure it is 22.16 cu. ft. per lb. When steam is expanded between these 2 pressures, through a turbine, the quality of the steam at the lower pressure is approximately 0.90. Therefore at the end, the volume of the steam is

$$\frac{22.16}{2.81} \times \frac{9}{10}$$ or little over 7 times as great as when entering the turbine.

To discharge this steam at a lower velocity than that of the entering steam it will require a pipe whose cross-sectional area is over 7 times as great as the 10-in. pipe.

The 36-in. pipe is approximately 13 times as great as the 10-in. pipe.

(Are you sure it is only a 10-in. pipe going to the turbine?)

Refrigerating Troubles

I AM having some trouble to get the temperatures down in our storage, and would like a little advice. We have a storage that holds 10,000 bbl. of apples which are coming in about 600 per day; cars are not iced. Our compressors are York inclosed, 2 in number, 17 tons refrigeration capacity each. We run both 8 hr. and one only 4 hr. We do not run nights, as we have gas engines and the neighbors won't stand for the exhaust noise. When I start in the morning, the rooms will frost and in 2 hr. will leave some of them, then it takes me until noon to get them frosted again. Temperature ranges from 36 to 58 at 6 a.m., and from 34 to 49 at 6 p.m. Water temperature, 54 deg. at intake, 82 deg. at outlet of condenser which is clean. Condenser pressure, 160 lb., low-pressure, 20-lb. gage.

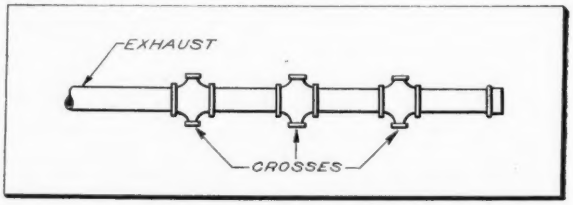
Last year some cars were iced, condenser was very foul and head pressure ran up to 180 and 200 lb., but we filled storage 3 weeks earlier this year, and we ran only one machine last year most of the time.

I lost a great deal of ammonia this summer by having a 1-in. nipple blowout of the oil separator, but have 400 lb. already to charge in.

We wish to bring our rooms down to 32 deg. in 12 hr. run with one machine, but it looks impossible to me. I have no way of telling the suction temperature, only that the pipe frosts back just as soon as a coil in the building gets frosted over. The discharge temperature is not known, only that it is so hot I can barely touch it with my bare hand.

When I have the rooms all frosted, as soon as they put in 25 or 30 bbl., the frost starts to leave the coil at the suction valve. My machine runs 150 r.p.m.

B. C. W.



MUFFLER FOR GAS ENGINE

A. We are inclined to believe that you lost more ammonia when the nipple blew out of the oil receiver than you thought, and the addition of 400 lb. was not sufficient. Before adding more ammonia, you should purge your condenser from any permanent gas that may be accumulated therein. The best way to remove these gases from the system is by drawing them off at the top of the condenser coils. It is advisable, when drawing off the gases, to make the condenser as cold as possible by closing down machine for a few hours, with water passing over or through condenser.

A small hose, or a permanent small pipe, may be attached to small valve which is attached to top of condenser for this purpose. The end of hose or pipe should be submerged in cold water (which may be in a bucket). If on opening the valve, bubbles are seen to escape through the water, the valve should be kept open as long as such bubbles continue to appear. If, however, a crackling noise should be heard in the water, the valve should be shut at once, as most of the permanent gases that can be removed at this time without undue loss of ammonia have been disposed of, at least for the time being.

You should now recharge with some good standard brand of ammonia and we do not advise mixing any of the several different brands of ammonia. The frosting of the coils when you first start up is due to the expansion valves leaking during the time you are closed down, and the rapid evaporation when first starting up, which causes the pipes to frost at once. The melting off is due to the lack of ammonia and the filling of room before the ammonia from expansion valves has time to work through to the several different coils.

You should charge your machines with enough ammonia, until, when placing your ear at expansion valve, you can hear a constant flow of ammonia, which

is distinguished by a constant gurgling sound. Any hissing at valve is a sure indication of gas passing through valve and indicates a low ammonia charge.

To cool a 10,000-bbl. storage room, will require about 25 tons refrigeration per 24 hr., and unless you can run one of your machines continuously, you had better start as early as possible before opening up doors and putting in more fruit. This would allow you to get temperatures in storage rooms down before being filled. Your rooms appear to be well insulated and to have the usual amount of piping for the purpose required.

The noise from your exhaust can be readily overcome so that it will not disturb your neighbors, by placing a muffler on exhaust pipe. This you can do by using a number of crosses with small side openings somewhat as shown in sketch.

Be sure that the side opening equals the area of the main exhaust pipe. In this way you can stop the objectionable noise.

Elevator Questions

HOW is the horsepower of an elevator figured?

2. How is the safe lifting capacity of an elevator calculated? G. R.

A. I take it you wish to know the power required to run an elevator. This depends on the efficiency of the elevator mechanism, the car speed and the load which it is to carry. As you know, the weight of the elevator car itself is always counterbalanced, and sometimes this is overbalanced, so that the car has to be pulled down instead of lifted up, until there is a considerable load on it.

If we take the unbalanced weight and add to it the weight of the live load, so as to get the actual weight moved, multiply this by the speed of the car in feet per minute, and divide by the efficiency and by 33,000, it gives the power which must be furnished to the elevator machinery. The live load is usually figured at 60 to 80 lb. per sq. ft. of floor space, and the weight of the elevator itself, 100 to 125 lb. per sq. ft.

With hydraulic elevators, usually about ¾ the weight of the car is counterbalanced, and the speed will average 400 ft. a minute for office buildings of medium size, the efficiency about 60 per cent.

For such a case, with an elevator having 30 sq. ft. of floor space, and assuming 70 lb. live load per square foot, and 100 lb. the weight of elevator per square foot, we should have the total live load $30 \times 70 = 2100$; the unbalanced elevator load, $30 \times 100 \times \frac{1}{4} = 750$ lb., or a total of 2850 lb. Multiply this by 400 ft. per minute, divide by 0.60 and by 33,000, and it will give us 54 hp. required. This is the power required by the elevator machinery, and, of course, the pumps would have to furnish still greater power because of the loss in transmission.

For electric elevators of the drum type, the elevator speed may be assumed on the average as the same—400 ft. a minute—the efficiency at 50 per cent. which is certainly on the side of safety.

In balancing such elevators, it is customary to counterbalance the entire weight of the car and half the maximum live load, so that when the car is half loaded, it is exactly balanced, and the only power required is to overcome friction. For full load, or for an empty car, the power required would be the same. The live load will be $30 \times 70 = 2100$; and as half this is counterbalanced, the weight to be lifted when going up full or when coming down empty, is half that amount, or 1050 lb. Multiplying this by 400 and dividing by 0.50, the efficiency, and by 33,000, gives 0.25 hp. This must probably be carried continuously, since the elevator will usually be full going up and empty coming down, when the full power would be required, or it will be empty going up and full coming down, when no power will be required.

In figuring the power required for the motor and generator, of course the efficiency of these machines must be taken into account.

2. The safe lifting capacity of an elevator depends on the load which the cables can carry. The only thing to guide here is the tables of Safe Rope Strengths, published by the elevator cable manufacturers, and, of course, an allowance must be made, in the case of worn cables, for the reduction in strength by wear and bending over the sheaves.

Cables are used for the lifting in both electric and hydraulic elevators, except for the direct plunger type. In the direct plunger elevator, where it is forced upward by hydraulic pressure on the lower end of the plunger, any load which the elevator can carry is, of course, safe—provided the plunger is guided against buckling. The load which it can lift would be equal to the area of the plunger in square inches times the water pressure per square inch available, and times 0.8 to allow for friction and leakage. A. L. R.

Grade of Steam Pipe

WE are about to install new machines in our lighting plant and will have to run new steam lines. Should the main line, that will run straight from the boilers through the engine room, be higher at the boilers than at the further end, or will the condensed steam drain back to the boilers if the end of line is the higher? T. S. T.

A. The correct pitch for your steam header is in the direction of the steam flow; that is, the header should be higher at the boiler than at the engine.

The reason for this construction is, that water cannot flow back to the boiler against the steam, and if the pipe is pitched towards the boilers, sufficient water might collect in slugs to result in a disastrous water hammer. If the water flows in the direction of the steam flow—away from the boiler—then no large quantity of water can collect at any one time.

Of course, in this case suitable provision must be made to drain the header at the engine, so as to prevent the water from passing into the steam cylinder.

F. W. B.

Safety Valve Area

WILL you kindly send me the latest way of figuring a pop safety valve? J. P. H.

A. First determine the weight of water in pounds to be evaporated per square foot of grate surface per second; multiply this by 770 and divide by the absolute pressure at which the safety valve is set to blow. The quotient will be the area of the safety valve in square inches per square foot of grate surface.

Embodied in the rules is a table showing the number of square feet which different diameters of valves will take care of, at different pressures, according to this rule. The rule and the table are given in the Practical Engineer Reference Tables for 1912.

A. L. R.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Resistance Problem

IF 12 pieces of wire, each having a resistance of 1 ohm, were soldered together so as to form the outlines of cube, as shown in the sketch, what would be

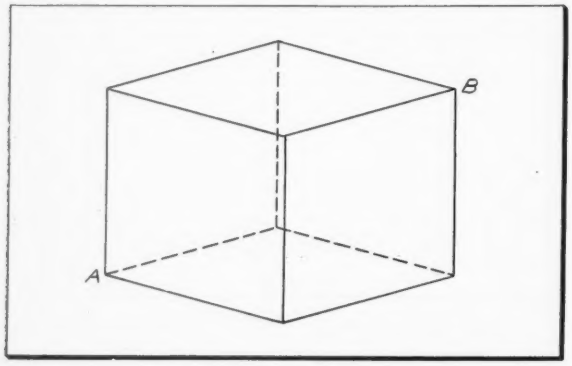


DIAGRAM OF CIRCUIT

the resistance between A and B, not allowing anything for the resistance in the joints? H. S.

Overhaul the Pump

IF on a surface condenser you have a wet and a dry vacuum pump the wet vacuum pump is controlled by a float in the hot well; you have 28 in. of vacuum, the water in the hot well is cold and the wet vacuum pump refuses to work. What would be the cause and what would you do? P. H.

Question for Readers

IN our plant is a 600-kw. high-pressure condensing steam turbine, connected to a surface condenser having 1900 sq. ft. of cooling surface, ¾-in. seamless drawn brass tubes, No. 18 B. W. G., 12 ft. 2 in. long. This condenser is figured to handle 14,400 lb. of exhaust steam an hour, giving 27 in. vacuum with a 30-in. barometer, and using 1450 gal. of water a minute at 80 deg. F. The circulating pump is 10 in. suction, 8 in. discharge, driven by a vertical engine on the same shaft as the vacuum pump. We are now using spray nozzles over the pond for cooling the water, but find that when we get sufficient pressure on the nozzles to do good work, it puts extra head on the circulating pump and we do not get enough water through the condenser; also, we sprinkle the whole neighborhood.

We want to use an atmospheric cooling tower, without fan, not exceeding 30 ft. in height, to cool not less than 1500 gal.—better 2000—a minute to a temperature of 80 deg. Our discharge from the condenser will average 95 to 100 deg., with 80 deg. inlet, and 105 to 110 deg., with 90 deg. inlet. I think that the pump taking circulating water through the condenser and back to the pond, will deliver 2000 gal. a minute with the head removed. I have a motor-driven pump, of the same size, which can be used to take water from the pond to the top of the tower.

Can some reader furnish dimensions of a tower to cool the water required as stated, with plans for distributing the water on the tower, and also what material should be used to give economy and durability? We have ground space 100 ft. square, on which the tower can be placed.

Heater Problem

IN the change in the feed water connections as proposed by H. Skaton, the idea of discharging the steam into the water line would probably give him some additional heat, but my advice would be to take out that make-shift heater that will not heat the water over 185 deg., with an ample supply of steam, and install a first-class open heater, several of which are advertised in this paper. The waste water from the transformers can be returned direct to the heater and the makeup water regulated by a float valve. The heater should set 4 to 6 ft. above the pump, and if enough steam is available the temperature of the water can be carried at 211 to 212 deg. or, if some back pressure is carried on the engine, it may be heated as high as 220 deg.

As the waste water from the transformers is slightly warmed, the induction arrangement that he proposes to use will help some, and the saving to be made by installing an effective heater would not be great, but I believe that his arrangement will be unsatisfactory and may cause serious water hammer. Furthermore, in case the feed pump slows down, or when the load on the engine is light and cutoff early, I see no reason why water will not be drawn back through his proposed connection into the exhaust pipe and possibly through the heater into the cylinder, which might prove serious as well as expensive. I should recommend a first-class open heater which would save him quite a lot of coal in a year, in preference to the proposed changes the success of which is doubtful.

J. C. Hawkins.

PRACTICAL REFRIGERATING ENGINEERS ASSOCIATION officials have decided, owing to the recent destructive fire, to change the meeting place of the fourth annual convention, Dec. 11, 12 and 13, from Hot Springs to Dallas, Texas. Present indications are that this will be the largest meeting in the history of the Association; many important papers on questions of interest to every refrigerating engineer have been promised. The meetings are open to all; every engineer, manager or owner of an ice or refrigerating plant is cordially invited to attend this convention and to take part in the discussion of such questions as interest them.

LODGE NIGHT

Guarding a Brother Engineer's Reputation

By John H. Ryan

I OFTEN think that the more interesting and valuable part of our lodge meetings is in the hour when the members are arriving and they congregate in groups of 3 or 4 and talk shop. Little anecdotes of happenings of the day, while they are fresh in the mind of the narrator, are more useful at this time when any minor details can be given to an inquirer. Later on, the man who did the work would remember only the result and be hazy about the manner in which it was obtained.

Some real and lasting lessons in the golden rule are often meted out to thoughtless youngsters who prate of their achievements in new positions.

Bud Moon got the job up at the rope walk when Charlie Howard quit on account of his rheumatism, and this evening Bud was happily engaged telling about the loose ends that Charlie had left for him to tie up. He didn't mean to belittle Charlie's ability, but was just telling us what a good mechanic he was. We all realized that it was not fair to Charlie and were glad when Frank Reid asked Bud if he would stop talking a minute and listen to a statement of how the matter seemed to some of the boys. Bud is a good fellow and said, "Go to it, old boy." Frank polished his shiny dome and rambled on in this manner.

"You young fellows never think how easily you may hurt a fellow engineer by thoughtless speech. You say that reputations do not count in these hurried times and that results are the only measure of a man's ability. All of which is true, but what gives an engineer the chance to demonstrate his ability? Is it not the reputation that someone gives him that lets him have the opportunity to show that his reputation was fairly earned?

"An engineer's reputation is his most valuable asset. It helps him to hold his present position and is of the greatest aid in procuring new and better positions. When an engineer steps into a new plant and everything is running along smoothly he should quickly see that as long as things are all right he is of no more benefit to his boss than a cheap man, and that his reputation is all that is keeping him on the payroll until the time comes when he may prove to his employer that the confidence in his ability was not misplaced."

Bud said he guessed Frank was right and that he and a lot more like him had hurt many a good man through their bluffing and dodging the consequences of mistakes due to their own ignorance.

It was the opinion of the group as we straightened out for the opening of the meeting that experience costs money and it did not make much difference to the plant owner in the matter of total cost whether he bought and paid for the experience of a cheap man or hired a high priced man for whom someone else had paid the cost of his mistakes.

The regular meeting developed considerable difference of opinion about the souvenir book and dance order for the annual ball. The opinions varied all the way from holding up our supply men friends for all the advertisements they would stand, to the other extreme of paying 50 cents apiece for the dance orders and cutting out the commercial feature altogether and inviting the supply men to join with us in a social evening. The matter was not decided, and is to come up again at the next meeting. The routine business of the meeting was uninteresting, and things were lagging until Will Lackey wanted to know the best way to answer an ad. for an engineer. There was a lot of good, bad and worse advice handed out. Then the president had a happy thought. He got out a recent issue of Practical Engineer and asked as many of the members present as cared to do so to write a specimen answer to an ad. in it for an engineer to take charge of the steam and electrical machinery in an automobile body factory. The letters were not signed and everybody was free to criticize the faults in each as it was read. All of them had some faults, but it was agreed that this was about the best offered:

St. Augustine, Fla., 12, 1, 1913.

"The Auto Body Co.,
Amesbury, Mass.

Gentlemen: The writer is a first class engineer, thoroughly experienced in the various applications of steam and electricity to the manufacture of wood and iron working machinery.

Age 36. Height 5 ft. 8 in. Weight 160 lb. Sight, hearing and health good.

Mr. Jas. Wright of the Wright Auto Co. will tell of my ability, intelligence and honesty.

Detailed experience and further references will be forwarded on request." (Signed)

It was claimed as its good points that it contained no excuse for writing, such as hearing that they needed an engineer. The reference was of a man in the same line of business whom they no doubt knew. The man who hires the engineer seldom knows what you are talking about when you write of Corliss and Brown engines, especially if he happens to have an old Putnam. About all you can expect is to create a favorable impression and get a request to call. Remember that there may be a hundred other applicants and you must get something in your letter that will stick in the employer's mind.

PURE WATER NECESSARY FOR ICE MAKING

THE rapid gain in popular favor which artificial ice has made in this country in recent years is shown by the reports of the United States Census.

In the manufacture of ice for household purposes and for cooling beverages it is important that the water used should meet all the requirements of potable water in respect to cleanliness and freedom from organic matter and disease germs. Most American manufacturers use distilled water in making ice, in order to get a pure, transparent product.

In the plate system, however, which is becoming more and more popular in this country, it is not necessary to use distilled water in order to obtain clear ice if suitable appliances are installed to prevent the occlusion of air and solid particles. Though it is true that the greater part of the bacteria and mineral matters in the raw water are excluded from the frozen plate, there is insufficient ground for assuming that perfectly harmless ice can be made directly from dangerously polluted water; and while it may be conceded that water pure enough for drinking is pure enough for making ice, it is nevertheless true that too much dependence should not be placed upon the natural purifying powers of the freezing process.—From Water-Supply Paper 233. United States Geological Survey.

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KNOW YOUR PLANT

How often, when you visit a power plant and make inquiry in regard to the details of the equipment, such as size and make of boiler feed pump, or size, make and type of valve, do you find the attendant informed on these points? Strange as it may seem, in the majority of cases the chief engineer, who has less to do with the actual handling of the apparatus, knows most about the details. Of course that is his business, he ought to know it; but are not the assistant engineer, the fireman, or even the oilers and coal passers held responsible for certain pieces of apparatus, every detail of which should be thoroughly impressed on their minds?

The principles involved in the smallest of steam plants are nearly as many and as difficult to comprehend as in the largest plants we have. True, one man may handle the entire plant, but if he is complete master of the situation he is well on his way towards success as chief engineer of a big plant.

To be a chief engineer worthy of the position requires a knowledge of his plant; he should know its details, what parts are weak, to what extent his boilers can be forced; the piping should be in his mind like a picture. Success comes to the man who meets emergencies; and, in a power plant, who knows what that emergency will be? How often have you, as chief engineer of a plant, been called up on the telephone by the night engineer who has had an accident and doesn't know what to do? Did he know how to tell you exactly what was wrong, and did you have the exact picture in your mind of what had occurred? If you did, in 9 out of 10 cases, you gave your instructions by telephone and went back to sleep. And why not? You knew if a valve had broken on the main header, that the automatic stop valve on the boilers would shut off the steam before it would be likely to injure any of the men and that the piping system was designed to handle just such an emergency. If one of the valves on your compound condensing Corliss engine went to the bad, you gave instructions to run 3 legged for the rest of the night, for your records had told you the load during that part of the run was always light.

We have all been told time and time again, by those who have made a success, to improve the opportunities that are presented to us if we desire to get ahead. Now here is an opportunity for every man in the plant, who has not already become master of it, to get an education equivalent, and in many cases superior, to that gained in a college laboratory, all at the expense of your employer. Learn your plant and you will have an equipment valuable in every plant.

NEWS NOTES

FROM DECEMBER 2ND TO 5TH, the annual meeting of the American Society of Mechanical Engineers, will be held in its rooms, 29 W. 39th St., New York. Tuesday evening will be devoted to the presidential address, followed by a reception. On Wednesday morning the business meeting will be held, followed by a professional session at which papers will be presented as follows: Operation of Large Boilers of the Detroit Edison Co., by J. W. Parker; Setting Tasks for Firemen and Maintaining High Efficiency, by Walter N. Polakov; Properties of Steam, by R. C. H. Heck.

On Wednesday afternoon simultaneous sessions will be held, one on railroad topics, including Steel Underframe Box Cars, by G. W. Rink; and Steel Frame Box Cars, by R. W. Burnett; on cement topics an informal discussion; on textiles, papers from the subcommittee on topics including Factory Timber, Cotton Conveying Systems, Safeguards Against Fire, Cost Keeping, and Systems for Heating in Textile Mills.

Wednesday evening will be devoted to the presentation of the Grashof Medal, awarded to George Westinghouse by the Society of German Engineers, followed by an address on Leonardo da Vinci, by J. W. Lieb, Jr.

Thursday morning will be taken up with a professional session at which papers will be presented on the Efficiency of Rope Driving, by E. H. Ahara; Comparative Tests of Line Shaft Bearings, by C. C. Thomas, E. R. Mauer, and L. E. Kelso; Pitot Tubes for Gas Measurement, by W. C. Rowse; Tests of Vacuum Cleaning Systems by J. R. McColl; Transmission of Heat in Vacuum Evaporators, by E. W. Kerr; Enameling of Steel or Iron With Glass, by R. F. Nailler. At the same time there will be sessions devoted to Machine Shop Practice, including papers on Continuous Manufacturing by Placing Machines in Accordance with Sequence of Operations, by Oscar F. Bornholt; Gears for Machine Tool Drives, by John Parker; Cast Iron for Machine Tool Parts, by Henry M. Wood; and A Record of Pressed Fits, by C. F. MacGill: on gas power including a New Process for Cleaning Producer Gas, by H. M. Smith; and other papers on gas and oil engine practice.

Thursday afternoon will be left free for excursions to points of interest in New York and vicinity, and Thursday evening will be given up to a reunion, taking the form of a German dinner which will reproduce one of those enjoyed by the party which went abroad last summer. An informal dance will follow the dinner, and a brief account of the trip will be given by Worcester R. Warner.

Friday morning the final professional session will be held, devoted to Fire Protection, and including papers on Fire Hazard in Turbo Generators, by G. S. Lawler; Extinguishing Fires in Oils and Volatile Liquids, by E. A. Barrier; Control of Automatic Sprinkler Valves, by Brent J. Miller. This will be followed by the announcement of the tellers of election, and the presentation of the President-elect.

Friday afternoon will be devoted to excursions about New York, and Friday evening a number of reunions of Alumni of Technical Colleges will be held, including Stevens Institute of Technology, Worcester Polytechnic Institute, Polytechnic Institute of Brooklyn, Yale University and Cornell University.

C. L. NEWCOMB, JR., has been appointed to succeed G. B. Turner as Western Representative of The Goulds Mfg. Co., Seneca Falls, N. Y. Mr. Newcomb's headquarters will be at 12 Chamber of Commerce, Denver, Colo., and he will look after the company's interest in the Rocky Mountains and Northwestern territories. Previous to this connection Mr. Newcomb has had several years' experience in the pump business and he is well known to the trade in the territory he will travel.

A RECENT ADDITION to the staff of the Centrifugal Pump Department of the A. S. Cameron Steam Pump Works, New York, is C. V. Kerr, the organizer of the Kerr Turbine Co., and later with McEwen Bros., of Wellsville, New York.

Mr. Kerr delivered an interesting address with stereoptican views on A New Centrifugal Pump with Helical Impeller at the November meeting of the American Society of Mechanical Engineers, at its rooms in New York City.

HAROLD D. TOMPKINS, a graduate of Cornell University and formerly associated with the Niles-Bement-Pond Co., of Philadelphia, has accepted the position of mechanical engineer with the Smooth-On Mfg. Co. of Jersey City, N. J., in charge of the concrete waterproofing department.

N. G. DOLL has accepted the position as general sales manager with Bury Compressor Co., of Erie, Pa.

MESSRS. W. A. KITTS, W. A. Kitts, Jr., and R. H. Hobbie, have resigned from the Kitts Mfg. Co., of Oswego, N. Y., and have formed the Kitts Steam Specialty Co., 60 E. First St., Oswego, N. Y., for the manufacture of the Kitts line of steam and water specialties.

W. E. WARREN, of the Westinghouse Electric Co.. of St. Louis, arrived in Cherryville, Kan., recently to look after the new electrical equipment which has been installed by the Edgar Zinc Co. at the smelter, to drive the motors at the power house to light the works and to heat the kilns.

GEORGE H. CLARKE, formerly Vice-President, Secretary and Sales Manager of the Dixon Cascade Pump Co., has severed his connection with that firm, and has become a member of Clarke & Lawrence Co., 292 Halsey St., Newark, N. J., to engage in manufacture of double suction centrifugal pumps.

RAILROADS COVERING nearly a billion locomotive miles are in the competition for the first award of the E. H. Harriman Memorial Medals, which will be made at the First International Exposition of Safety and Sanitation, to be held in New York City, December 11 to 20, under the auspices of the American Museum of Safety.

Several notable names have been added to the Jury of Award, including Vincent Astor, Mabel T. Boardman, and John H. Finley. The complete Jury now consists of Jane Addams, Vincent Astor, Mrs. August Belmont, Surgeon-General Rupert Blue, Mabel T. Boardman, George B. Cortelyou, John H. Finley, Irving Fisher, Elbert H. Gary, Prof. F. R. Hutton, Joseph Johnson, J. B. McCall, President of the National Electric Light Association; Dr. William H. Nichols, John H. Patterson, F. E. Rogers, B. B. Thayer, Lillian Wald, W. T. Wilson.

The Safety Exposition will be the occasion of the annual meeting and dinner of the American Museum of Safety, which will be held at the Waldorf-Astoria on the evening of December 12. One of the speakers will be Pres. Arthur T. Hadley of Yale. The dinner committee consists of James Speyer, George B. Cortelyou, Judge E. H. Gary, Dr. George F. Kunz, and Dr. William H. Tolman. All of the awards will be made on this occasion, including the Harriman Memorial Medals, the Safety Exposition Medals, and the annual medals of the American Museum of Safety, consisting of The Scientific American, the Travelers, the Seaman and Rathenau medals.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

COCHRANE METERING HEATER

The V Notch Used in Connection with Open Feed Water Heater Makes Possible the Recording of Feed Water Supplied

IN the Cochrane metering heater, or combined open feed water heater and meter, the settling chamber of the heater is utilized as the still water or approach chamber for the V-notch weir. A float in the outflow chamber on the down-stream side of the weir controls the cold water valve, through which makeup water is admitted to the heater, and the open space above the water in the weir chamber is connected to the steam space of the heater by a suitable equalizing pipe, thus making a complete self-contained unit, performing all the functions of the open feed water heater in addition to those of a water meter.

Enclosing of the weir within the heater makes it possible to meter water at any temperature, without annoyance or loss of heat from escape of vapor; space, valves, piping, etc., are economized; storage capacity to absorb pulsations due to the action of the pumps is provided, thus insuring legible records; impairment of the accuracy of the meter through accumulation of scale or sludge is easily prevented; and a form of meter is secured in which the accuracy of the recording mechanism is easily checked by the user, by reading the head of water upon the weir, and calculating the corresponding discharge from a formula.

The Cochrane metering heater is supplied in all modifications in which open heaters are built; that is. for plants where the engines exhaust freely to atmosphere, the standard type of construction, with a water seal for the escape of oily drips from the separator and overflow from the heater, is employed; while in plants where the heater is to be operated under back pressure, the overflow is taken care of by a float-controlled trap. The heater is also built with an oil separator of sufficient capacity to purify all the steam exhausted by the engine, the steam for the heating system passing directly out through a stack at the top of the separator and only such steam entering the heater as is required to heat the feed water. In this arrangement, valves are provided for cutting the separator and drainage tank out of communication with the body of the heater, so that the latter may be cleaned or inspected while the separator continues in service. Where the water requires softening, the apparatus is modified to provide for the automatic introduction of softening reagents, and for sufficiently large settling and filtering capacity to remove the resulting precipitate. Where headroom is limited, or large water storage capacity is required, a cylindrical form of heater is recommended, and where only part of the water is to be metered, 2-compartment heaters are supplied, for a heater may be arranged to meter 2 supplies of water used separately.

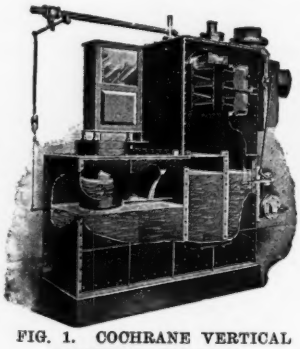


FIG. 1. COCHRANE VERTICAL METERING HEATER

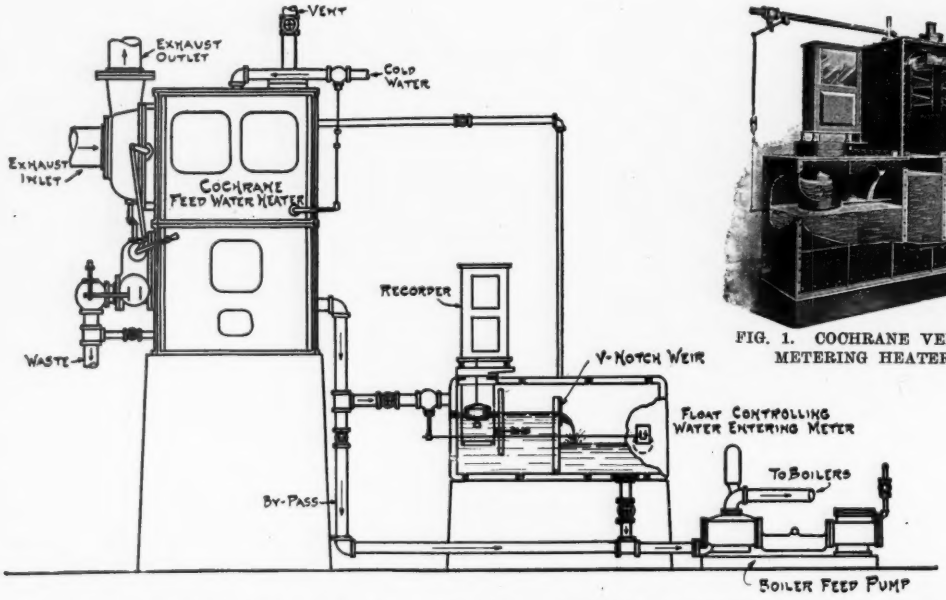


FIG. 2. DIAGRAM SHOWING PRINCIPLE OF THE COCHRANE COMBINED OPEN FEED WATER HEATER AND METER

Provision is also made for converting open feed water heaters already installed into metering heaters by the addition of a weir chamber suitably connected to the heater by a water pipe and a vapor equalizing pipe, and where closed heaters are installed, the weir chamber takes the form of a metering hot well, serving also as an automatic make-up water regulator.

The registering and recording mechanism employed in connection with the Cochrane metering heater and the independent meter and metering hot well is a simple mechanical device operated by a large copper float located in a chamber connected through a throttle or choke valve to the still water chamber, and enclosed within the heater construction. From the float a polished brass rod rises vertically through a stuffing box or anti-vapor gland into the recorder casing, where it carries a vertical rack engaging with a pinion mounted on the spindle of a plate bearing a spiral cam. This cam is so laid out that a pen carriage is caused to travel equal distances horizontally for equal increments in the rate of flow. The pen in turn bears upon a drum which is revolved once in 24 hr. by an 8-day clock. The chart upon which the record is made is wrapped around this drum, and inasmuch as distances crosswise represent flow in pounds per hour, and distances lengthwise represent hours, the area of the chart under the pen tracing represents, to an appropriate scale, the total flow in pounds of water during any given period.

The area under the curve may be determined either by means of an ordinary engine indicator planimeter, or an automatic integrating device can be provided which gives directly the total flow corresponding to any elapsed period.

The vertical tack rod of the recorder is fitted with a pointer traveling over a scale divided into inches, which serves the double purpose of affording an easy means of initial adjustment of the instrument, and of computing the flow directly, independently of the cam. The surface of the cam is also marked so that the flow may be read off independently of the pen, furnishing a means for adjusting or checking the adjustment of the pen upon the chart at any time.

These meters are guaranteed to give a result that will agree with the amount of water as determined by weighing, within 1½ per cent, variations in temperature of the water not to exceed 25 deg. F. above or below the temperature for which the instrument is designed.

The Cochrane metering heaters, also metering hot wells and independent meters installed in connection with open or closed feed water heaters, are manufactured by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa.

PRODUCTION OF PIG IRON in 1912 was 33,802,685 tons of 2000 lb. each; that of platinum was 1.3 tons. The value of the iron per ton was $12.44, as against $1,328.391 per ton for the platinum.

For the sake of convenient comparison the production of some of the better known metals may be of interest.

	Quantity	Value
Platinum	1.304	$ 1,732,221
Gold	188.108	113,415,510
Silver	4,471.4	80,187,317
Aluminum	32,803	15,089,380
Quicksilver	939.9	1,057,180
Nickel	22,421	17,936,800
Tin	8.4	8,850
Copper	734,052	242,337,160

THE BIGGEST TRAP IN THE WORLD

ORDINARILY a steam trap is thought of as a small auxiliary device for the handling of drip and moderate amounts of condensation. A recent application in a sugar house in San Domingo is of large machinery size, however, and is interesting as an advance over anything previously done. This is a trap with 6-in. inlet and outlet, installed at the Centrale Consuelo, Macarese, San Domingo, and sold by the Lytton Mfg. Co. to Bartram Bros., of New York City.

TWO LYTTON TRAPS, THAT TO THE RIGHT THE LARGEST IN THE WORLD

The trap is 30 in. in diameter by 80 in. high, and is designed to handle 30 tons of water an hour, or 1000 lb. a minute. It will take care, however, of a 50 per cent overload, or 1500 lb. a minute, and will work on a range from 6-lb. pressure to 6-in. vacuum, either steady or varying. It is designed to work on the first cell of a quadruple effect apparatus of 600,000-gal. capacity, and was designed by D. J. Lewis, of New York, Sales Manager for the Lytton Mfg. Co.

PRODUCTION OF COAL in Illinois, in 1912, reached the great total of 59,885,226 short tons, with a value at the mines of $70,294,338. These are record-breaking figures for the State, according to E. W. Parker, the coal statistician of the United States Geological Survey.

There are 102 counties in Illinois, and coal is mined in just one-half of them. The coal formations underlie a number of other counties, the total productive territory occupying nearly ¾ of the entire State. The total coal area is estimated at 35,600 square miles, a larger area than in any other State east of Mississippi River, and exceeded only by the coal fields of Montana and North Dakota. The Illinois coal fields comprise the western part of a broad, relatively flat basin whose eastern border is in the western part of Indiana and whose southern extremity extends under Ohio River into Kentucky.

TRAP CAPACITY TEST

UNDER actual working conditions, a test for efficiency and trap capacity of 5 different traps was made September 20, 1913, in the plant of the Lane Technical High School, Chicago, Ill. The test was conducted by 2 supervising engineers, from the office of the chief engineer of the Board of Education of the City of Chicago, the traps being arranged and connected as shown in the illustration. Discharge from each trap was connected to the suction of a vacuum pump; each trap had a water gage to show its performance and operation, and was arranged with valves at both inlet and outlet, for cutting the trap in or out of operation. The traps were connected to drain 12 radiators, 78 in. high, containing about 3300 sq. ft. of heating surface, with a 4 by 6-in. blower, operating at 200 r.p.m., on each end. These coils are in the north main heating plant of the school, and are part of the heating system for the building.

In order to give all traps the same conditions at starting of a test, previous to placing a trap in service, the condensation was blown into the sewer until dry steam appeared so that each trap had to handle only the actual amount of condensation accumulated while the trap was in operation. Traps tested had a rating at least equal to the amount of radiation drained, and were tested in order beginning with the trap marked A on the illustration. The trap A had 1¼-in. inlet and outlet, and a catalog capacity rating for 10,000 ft. of 1-in. pipe. The next trap, B, had 1½-in. inlet and outlet, and catalog capacity rating of 15,000 ft. Trap C, although connected, was not tested, as its agent stated that such test would be useless, after the results obtained from traps A and B. Trap D had 1¼-in. inlet and outlet, and trap E, 1½-in. inlet and outlet.

TRAPS	Boiler Pressure	Pressure on Rads. Back Pressure	Inches Vacuum	Temp. of Condens.	Outside Temp.	Duration of Test	Trap Pipe Inlet	Trap Pipe Outlet	REMARKS
A	53 lb.	3 lb.	18	208°	57°	7 min.	1¼	1¼	Trap immediately flooded and never operated. Test abandoned in 7 min.
B	53	3	12	208	57	3	1½	1½	Trap immediately flooded and never operated. Test abandoned in 3 min.
C	53	3			57		¾	¾	No Test made.
D	53	3	8–17	208	57	7	1¼	1¼	Trap operated properly 1 min., then hung for 2 min then operated properly balance of time.
E	53	3	8–13	208	57	7	1½	1½	Trap operated perfectly all the time..

MISCELLANEOUS TESTS

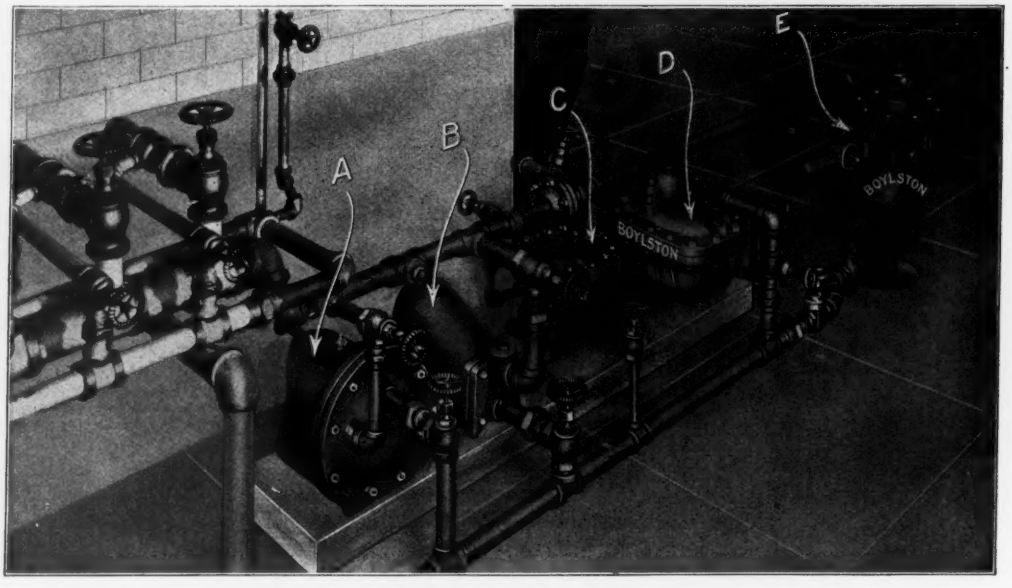
Trap marked B—Vacuum Pump operated without water spray. Result, trap flooded and test abandoned in 4 min.

Trap D—Vacuum Pump operated without water spray. Result, trap operated properly and perfectly. Time 5 min.

Trap E—Vacuum Pump operated without water spray. Result, trap operated properly and perfectly. Time 6 min.

Trap E—Valve to trap closed and system allowed to fill for 2 min., valve then opened and trap cleared all condensation in 1 min.

It will be noted from the test as shown in the table, and also from the miscellaneous tests, that the inlet and outlet connections of a trap are not necessarily an indication of what the trap will do. For instance, trap B, with 1½-in. connections and a rating of 15,000 ft. of 1-in. pipe, or 5000 sq. ft. of heating surface, actually took care of less condensation than trap A, with only 1¼-in. connections; while trap E, with 1½-in. connections, was, from the showing of the miscellaneous test, in which it was allowed to fill for 2 min. and then relieved itself of all condensation within 1 min., able to care for at least 3 times the amount of radiation attached to it during the test.



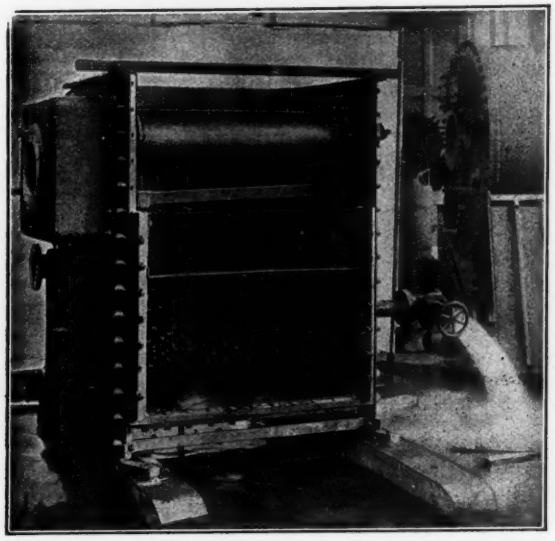
ARRANGEMENT OF STEAM TRAPS FOR TEST OF CAPACITIES

The results of tests for operation and capacity are shown in the table herewith, which is exactly as given in the report of the examining engineers, a copy of which was sent to Practical Engineer and is on file at this office:

WATER FLOW IN NATIONAL DIRECT-CONTACT HEATER

IN order to show the actual flow of water in a National direct-contact heater, a demonstration was made in the shops of the maker, The National Pipe Bending Co., New Haven, Conn., by making one side of the rectangular heater of glass for this purpose. One side of the heater was removed by taking out the corner bolts which, by the way, pass through lugs cast on the edges of the plate in such manner that the bolts are parallel with the diagonal of the cube, thus securely bolting together the bearing surfaces of the plate which are accurately machined for good contact.

The photograph shown was taken while the water was flowing through the heater at the rate of 850 hp. per hour, the heater having a capacity of 1000 hp. The water entering the smaller pipe of the double-pipe casting overflows at the top through a long port and follows the cylindrical surface of the outside of the pipe in the form of a thin film, which, being transparent, shows in the photograph merely as the pipe. At the bottom of the pipe casting there are 2 ribs or lips projecting from the port opening which tend to break up the film of water into fine streams as shown. In power-plant operation, the steam within the larger pipe of the double-pipe casting leaves the casting through a port at the bottom and passes through these fine streams of water.



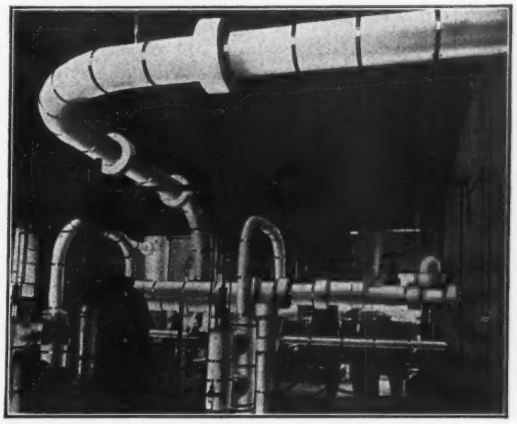
NATIONAL DIRECT-CONTACT HEATER WITH GLASS SIDE TO SHOW OPERATION

It will be readily seen that the water is heated by the steam surface contact while within the pipe above referred to, and is still further heated by actual mingling when it forms the curtain through which the steam passes. The hot water drops to a tray or trough beneath the pipe casting and is conducted to the bottom of the heater from which it flows upward through the filtering material to the reservoir just above. From this point it is taken from the heater to be supplied to the boiler.

When installed in a power plant, the steam pipe is connected to the oil separator at the left which with this form of heater is rectangular instead of circular as in the case of the cylindrical heater or in a pipe line.

REDUCING CONDENSATION

WHEN a city realizes that it is losing money through imperfect insulation in one of its big municipal departments it is time to make investigations. And that is just what was recently done in Middletown, Ohio, by John Lloyd, the progressive director of Public Safety, who found that the city's water works could make a big saving by a complete revolution in the method of covering steam pipes throughout the big plant.



INSULATED STEAM PIPES OF MIDDLETOWN, OHIO, WATER WORKS

Tests extending over a period of several months were made on the principal pipe coverings and insulating materials on the market, and it was eventually decided to use the J-M Asbesto-Sponge Felted Pipe and Boiler Covering, made of layers of thin felt composed of pure asbestos fiber and finely ground sponge.

NEW POWER PLANTS

AN ELECTRIC LIGHT PLANT has recently been erected at De Ridder, La.

CITIZENS OF EDGEWOOD, IOWA, have bonded themselves to the amount of $12,000 for the erection and equipment of an electric light plant.

THE SOUTHERN CALIFORNIA EDISON CO. will commence the construction of a half million dollar plant near Slide Lake in the Santa Ana Canyon, where preliminary work has been under way for some time.

THE EDISON ILLUMINATING CO. has started the erection of a plant at Connors Creek, Mich., representing an outlay of several million dollars; 40,000 kw. will be produced. The new plant will cut the length of transmission.

WORK ON THE MUNICIPAL LIGHTING PLANT at Elgin, Ill., will be started as soon as specifications can be drawn, according to an announcement made by Mayor Fehman, following the action of the council in securing the services of the C. A. Chapman Co. to install the plant.

AT A RECENT MEETING of the trustees of the Shamokin, Pa., hospital, Architect William H. Lee presented his plans for the new boiler and power house, heating system, electrical equipment and additions to the nurses' home and laundry buildings. The plans were gone over in every detail by the members of the board and were accepted after due deliberation.

THE ALABAMA POWER CO. is making arrangements to establish one of its steam power units in Huntsville, Ala., and will build a plant there costing approximately $125,000. This plant will supply Huntsville and contiguous territory with electricity in emergencies when electricity generated by water power is not available. It is stated that the new plant will be in operation within the next few months and it is likely that it will be ready for service before the transmission lines are brought there from rivers southwest.

THE PLANT OF the Richmond Light and Railroad Company, at Livingston, L. I., where one of the boilers exploded recently and killed 7 and injured several others, is going to be entirely rebuilt and new machinery installed, according to the announcement of the officials of the company. The new machinery will have a capacity of more than double the former energy of the old plant. A contract has been made for 4 new Babcock and Wilcox 600-hp. boilers, with Taylor automatic self stokers, and all the modern devices known to electric and engineering enterprise will be put in. A new 4000-hp. turbine generator was contracted for some time ago and is now on its way. This one engine alone is capable of giving sufficient power to handle all the present business of the company.

CONSTRUCTION WORK upon the Skagit power project will be begun soon, according to a bulletin from the Secretary of Agriculture, who recently granted the Skagit Power Co. a permit for the development of 2 sites on the Skagit and Cascade rivers within the Washington national forest reserve. The construction will consist of a concrete diverting dam, 50 ft. in height, a tunnel conduit, 3.7 miles in length and a power house on Skagit River about 150 miles north of Tacoma. A large part of the power output is expected to be marketed in Seattle.

In developing power from the Cascade River, the flow will be diverted by a concrete dam having a height of 20 ft. and a maximum length of about 200 ft. A flume and tunnel will carry the water a distance of approximately 6 miles to the proposed power house.

Machinery capable of generating over 50,000 hp. will be installed at the 2 power houses, according to the estimates of the engineers.

BOOKS AND CATALOGS

THE FOLLOWING CIRCULARS may be obtained free of charge from the Secretary of the Interior, Washington, D. C.:

National park pictures collected and exhibited by the Department of the Interior; 16 pp. A descriptive list of pictures exhibited at public libraries by the Department of the Interior. Contains short descriptions quoted from well-known writers, but does not contain illustrations.

The following information circulars contain data regarding hotels, camps, and principal points of interest, lists of books and magazine articles, sketch maps, and rules and regulations:

General information regarding Yellowstone National Park; 36 pp.

General information regarding Yosemite National Park; 28 pp.

General information regarding Mount Rainier National Park; 22 pp.

General information regarding Crater Lake National Park; 12 pp.

General information regarding Mesa Verde National Park; 24 pp.

General information regarding Sequoia and General Grant National Parks; 24 pp.

General information regarding the Hot Springs of Arkansas; 8 pp.

General information regarding Glacier National Park; 16 pp.

THE FOLLOWING NATIONAL PARK PUBLICATIONS are for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C.:

Geological History of the Yellowstone National Park, by Arnold Hague; 24 pages, including 10 illustrations; 10 cents.

Geysers, by Walter Harvey Weed; 32 pages, including 23 illustrations; 10 cents.

Geological History of Crater Lake, Oregon, by Joseph S. Diller; 32 pages, including 28 illustrations; 10 cents.

Some Lakes of Glacier National Park, by M. J. Elrod; 32 pages, including 19 illustrations; 10 cents.

Sketch of Yosemite National Park and an Account of the Origin of the Yosemite and Hetch Hetchy Valleys, by F. E. Matthes; 48 pages, including 24 illustrations; 10 cents.

The Secret of the Big Trees: Yosemite, Sequoia, and General Grant National Parks, by Ellsworth Huntington; 24 pages, including 14 illustrations; 5 cents. Contains an account of the climatic changes indicated by the growth rings and compares climatic conditions in California with those in Asia.

Analyses of the Waters of the Hot Springs of Arkansas, by J. K. Haywood, and Geological Sketch of Hot Springs, Ark., by Walter Harvey Weed; 56 pages; 10 cents.

Proceedings of the National Park Conference held at Yellowstone National Park, September 11 and 12, 1911; 210 pages; 15 cents. Contains a discussion of National Park problems by officers of the Government and other persons.

Proceedings of the National Park Conference held at the Yosemite National Park, October 14, 15, and 16, 1912; 146 pages; 15 cents. Consists mainly of a discussion regarding the advisability of admitting automobiles to the National parks.

Remittances for these publications should be by money order, payable to the Superintendent of Documents, Government Printing Office, Washington, D. C., or in cash. Checks and postage stamps cannot be accepted.

LYTTON PERFECT VACUUM and Lifting Trap is the subject of a circular lately issued by Lytton Manufacturing Corporation, 50 Church St., New York.

SMOOTH-ON MFG. CO.'S latest circular regarding Smooth-On Iron Cement No. 7, for surfacing and stopping leaks in concrete, has just been received. The company will be pleased to send one of these circulars to any reader sending his name and address to Smooth-On Mfg. Co., Jersey City, N. J.

A NEW FOUNTAIN DRAWING PEN in which the ink is contained in a rubber reservoir within the handle and is fed to the blades in any desired quantity by a slight pressure of the finger on a conveniently placed lever, is described in an illustrated circular from Keuffel & Esser Co., 127 Fulton St., New York.

THE HOPPES MFG. CO., Springfield, Ohio, has issued a new catalog illustrating and describing the Hoppes feed-water heaters, live steam purifiers, steam and oil separators and exhaust heads. A copy of the catalog will be mailed on request.

OCTAGON PATTERN and several other types of "Kewanee" union are illustrated in a 4-page circular recently issued by National Tube Co., Pittsburgh, Pa. Copies of the circular can be obtained on request at all offices of the company.

THOSE THIN, SMOOTH metal edges of the 6-in. boxwood pocket rules that were received from the Chicago Retort and Fire Brick Co. of 72 West Adams St., Chicago, Ill., are most convenient for opening letters and papers, drawing lines with pen or pencil and making sketches. They prevent chipping or splitting of the edge, too, and will be appreciated by all who receive one of the rules which the Fire Brick Co. is glad to send free to those mentioning Practical Engineer.

VULCAN SOOT CLEANER is the subject of a 48-page illustrated catalog giving a presentation of soot cleaning as applied to all types of water-tube

and return-tubular boilers, with particular reference to the Vulcan system, and containing some valuable engineering data. Copies of the catalog may be obtained by addressing G. L. Simonds & Co., 115 So. La Salle St., Chicago.

ELECTRICALLY-DRIVEN PICKERS is the subject of the latest issue of Westinghouse Textile Quarterly issued at frequent intervals by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., on the subject of Motor Drive in Textile Mills.

The pamphlet describes in some detail 4 methods of drive used for pickers together with illustrations of each. Detail views of the motors adapted to this service and the method of mounting them are shown. A number of graphic meter curves illustrating the load on this type of machine are also given.

THE INTERNATIONAL ENGINEERING WORKS, LTD., manufacturer of Robb Engines and Boilers, has just published a new bulletin entitled, "Robb Scotch Boilers."

The advantages of this boiler are fully described in the bulletin which gives particulars as to an economy test which was run at Bush & Terry's Power Plant, Philadelphia, of a 200-hp. boiler on fluctuating load, showing an average combined efficiency of 73 per cent.

The International Engineering Works, Ltd., having a sales office at 131 State St., Boston, will be glad to send this bulletin on request.

"STEAM PLANT ECONOMIES Due to the Use of Hot Soft Water in the Boilers" is discussed in a 28-page booklet just issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa. This publication discusses the superior results obtained by treating the water when it is hot, rather than cold. It is claimed that the speed of chemical reactions is greater in hot water than in cold water; that the resulting precipitate is coarser and hence settles more rapidly, requiring less time for settlement and resulting in more thorough precipitation; and, also, that the solubility of the residual products is less in hot water than in cold, so that with the hot process system it is possible to guarantee a much lower content of scale-forming solids in the softened water than can be done with cold process systems.

The Sorge-Cochrane Hot Process System of the vertical and horizontal types is also described, and the different processes employed under different plant conditions are outlined as where the water contains temporary hardness only, where it contains large amounts of sulphates or permanent hardness, where only part of the water requires softening, where the water contains quantities of magnesia in addition to permanent hardness, and where the softened water is wanted cold. The Sorge-Cochrane Hot Process Water Softening System combines with the functions of a water softening apparatus those of an open feed water heater, which may be used with engines exhausting free to atmosphere or, against back pressure, or which may take the form of the Cochrane metering heater, which indicates and records the rate of flow to the boilers.

TRADE NOTES

SPRAY ENGINEERING CO., of 201 Devonshire St., Boston, has opened up a branch office at Room 954, Monadnock Building, Chicago.

IN STANDISH HALL, the first of the group of Harvard Freshmen Dormitories, there are to be installed 9 storage heaters now being built by the National Pipe Bending Co. of New Haven, Conn. These heaters are as follows: 6 having 300 gal. capacity, 2 200 gal., and one 100 gal. They are to be used for supplying hot water for domestic purposes, kitchen, etc. This dormitory, designed by Shepley, Rutan & Coolidge, will accommodate 130 persons, with dining room to seat all students at once. The common living room is 33 by 44 ft.

THE KERR TURBINE CO., Wellsville, N. Y., reports the following among recent sales of Economy Turbines: 2 1000-hp. units to drive pumps furnishing 20,000,000 gal. a day for the main water supply for the Edgar Thompson Steel Co., Pittsburgh, Pa.; 8 200-hp. and 8 22-hp. units to serve condensing equipment, Duquesne Light Co., Pittsburgh; 2 65-hp. units to drive gas blowers, New Britain (Conn.) Gas Light Co., one 275-hp. unit to drive pump, for export by John Simmons Co.; 2 50-kw. turbo-generators, N. Carolina Teachers' Training School, Greenville, N. C.; one 500-kw. turbo-alternator, Citizens' Electric Co., Williamsport, Pa.; one 205-hp. unit to drive pump, Merchants' Heat & Light Co., Indian-

apolis, Ind.; one 100-kw. turbo-generator, J. B. Jenkins Coal & Coke Co., Elkins, W. Va.; one 155-hp. unit to serve condensing equipment, Citizens' Heat, Light & Power Co., Johnstown, Pa.; one 250-hp. unit to drive pump, Phipps Power Station, Duquesne Light Co., Pittsburgh and one 225-hp. unit to drive pump, Swift & Co., Chicago.

AMONG THE COMPANIES that have recently installed or are now installing National direct-contact feed water heaters, are the following: Rhode Island Co., Providence, R. I., 24,000 hp.; Connecticut Co., Hartford, Conn., 6000 hp.; Berkshire Street Ry. Co., Zylonite, Mass., 4000 hp.; Meriden Electric Light Co., Meriden, Conn., 3000 hp.; Connecticut Co., New Haven, Conn., 2000 hp.; Wilkesbarre Lace Co., Wilkesbarre,Pa., 2000 hp.; Berkshire Street Ry. Co , Pittsfield, Mass., 2000 hp.; American Brass Co., Waterbury, Conn., 2500 hp.; Chase Rolling Mill Co., Waterbury, Conn., 1000 hp.; and Saxonville Mills, Saxonville, Mass., 1500 hp.

This type of heater is relatively new, but is meeting with great success as these installations indicate. It is the horizontal type, having contact pipes. When the steam and water first meet in the heater, the water is in the smaller pipe surrounded by the steam. At this period the water becomes warmed from the steam and is later heated to maximum temperature by mingling with the steam, which is accomplished by directing the flow of steam through the water which escapes as a thin film from the slot or port at the top of the pipe.

An efficient arrangement of filtering material with the oil separator for taking the oil out of the steam before it mingles with the water, makes this heater serve the various purposes of a feed water heater, purifier, storage tank, oil separator, etc.

AT A RECENT MEETING of the Executive Committee of the Westinghouse Machine Co., an appropriation of $125,000 was made to provide additional manufacturing facilities.

The additional equipment is required to take care of the rapidly increasing business which the company has been enjoying recently, owing in a large measure to the new lines of products developed, particularly the following: The impulse turbine, which is being used in large numbers by central stations, railways and industrial plants; the reduction gear which, in addition to the demand for marine installation, is finding a wide field of application in connection with the large direct-current generators. The gear is interposed between the high speed of the turbine and the low speed of the direct-current machine with its commutator. Orders for automobile rotary valve motors have also contributed to increasing need for additional equipment.

The department manufacturing air springs for automobile trucks has also felt the influence of increased business and additional manufacturing facilities are required for it. These air springs are interposed between the chassis and the body of the truck and thus materially reduce the jar and vibration. They have proved exceedingly popular for this class of vehicle.

The company contemplates devoting a portion of the appropriation to securing additional machine tools designed to use high-speed tool steel, fully realizing their advantages, and thus adding to the already well equipped shop which this company now has in operation.

PRACTICAL ENGINEER
Trade-mark, Reg. U. S. Pat. Off.
SEMI-MONTHLY
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

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No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Positions Wanted

POSITION WANTED—By young man as second engineer or will take complete charge of small plant. 7 years' experience. Tools, indicator and references. Sober, industrious and agree with work. Open for engagement by Nov. 1st. Box 15, Argyle, Minn. 11-15-1

POSITION WANTED—Am practical, all around engineer and electrician 25 yrs.' experience with Corliss and Turbine engines, A.C. and D.C. generators. Correspondence solicited. Address Box 326, Practical Engineer. 11-15-1

POSITION WANTED—By engineer. At present employed in plant of 2000 H. P. Have had 10 yrs.' experience in large plants. Mass. license. Address Box 327, Practical Engineer. 11-15-1

POSITION WANTED—Chief Engineer, factory power plant, wide experience; result producer. Address Box 329 Practical Engineer. 12-11

Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well-known boiler specialty in your territory for an old established manufacturer in the power plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf.

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, single and compound with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—Every local Engineers' Association to have an assortment of valuable power plant books—Secretary write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write us at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

SALESMEN WANTED for Warley's Boiler Cleansing Chemicals as side line. Good teritory open for the right men. Good commissions to start. Some of our most successful salesmen, who are now giving their entire time to our line, started in this way. State age, reference, line now handling, and territory now covering. Address Thos. C. Warley & Co., 221 So. Front St., Philadelphia, Pa. Established 1889. 12-1-1

WANTED—An additional subscription solicitor wanted to cover towns in the state of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf

For Sale

AIR FRICTION CARBURETORS with new 1914 improvements, increase power and economy of motor one-half; absolutely impossible to choke or load like other carburetors; uses distillate, gasoline or half kerosene with finest results; starts easy in coldest weather; we fit all motors; guaranteeing definite results or refund money; exclusive county rights; special price first order. The Air Friction Carburetor Co., Dayton, Ohio. 12-1-1

ENGINES FOR SALE—Two (2) 13 and 20 by 16 Ball and Wood Tandem Compound Horizontal Automatic Center Crank Engines. In first class order and complete, with all regular attachments. Ready for immediate delivery. Price $350.00 each, f.o.b. cars Binghamton, N. Y. F. H. Herring, Inc., 30 Church St., New York, N. Y. 11-15-2

FOR SALE—14 by 42 Wheelock Engine Wheel 9 ft. by 20 ins. Also Bulkley Condenser in first class condition, and National Heater with double coil, back pressure valve and exhaust head. Address M. Heminway & Sons Silk Co., Watertown, Mass. 12-1-1

FOR SALE—One 150-H.P. Cooper-Corliss engine with belting and accessories in first-class condition, at a very attractive price. Rochester Drop Forge Co., Rochester, N. Y. 11-15-2

OUR MODERN BLUE PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

FOR SALE—24 by 48 Hamilton Corliss Engine, having tangye frame (practically new). $1200; immediate shipment. Duzets & Sons, 40 Church St., New York. 12-1-2

FOR SALE—½ H.P. motor and supplies. F. P. Hobert, 15 Gate St., Poughkeepsie, N. Y. 12-1-1

Patents and Patent Attorneys

PATENT SECURED or fee returned—Send sketch for free expert search and report as to patentability. Books on inventions and patents, and refernce book sent free. John S. Duffie & Co., 607 F St., Washington, D. C. tf.

PATENTS PROCURED and sold. Send sketch for free search. Free drawings furnished with each application. The Patent Exchange. Garban Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENTS SECURED. Legal protection our specialty. Booklet free. Harry Patton Co., Suite 330, McGill Building, Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather.

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Ave., St. Louis, Mo. 11-15-5

Miscellaneous

ENGINEERS desiring valuable data on Boiler Operation, should write for our new booklet—it's free if you tell us where you saw our ad. The Federal Graphite Mills, Cleveland, Ohio. 11-15-3

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water Purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf.

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks On The Advertising Pages

It is well known that cities, churches, undertakers, and even cemeteries, are among the peculiar subjects and articles advertised, but it is, probably, information to the average person that advertising had a great deal to do with the election of President Wilson.

The method of advertising is thus described by Stanley Clague, who handled the advertising for the Democratic National Committee in the presidential campaign:

* * *

"The campaign, which resulted in the election of President Wilson, was 'different' in many ways, but in no way did it depart more from the beaten path than in its advertising," said Mr. Clague, in telling how it was managed. "The great convention at Baltimore had brought many young men to the front in Democratic politics—men like Chairman McCombs and Secretary Joseph Davies, the latter now Commissioner of Corporations—and they wanted the advertising to reflect the spirit of the campaign they were carrying on.

"The plan we proposed was based upon the proposition that the direct support of the voters was to be sought. It also included a strong argumentative series of advertisements, which set forth in some detail the entire Democratic program. Each 'ad' carried a coupon with a direct appeal to the citizen to contribute, according to his means, to the support of the Wilson campaign.

"We had only six weeks to serve about 3,000 daily and weekly newspaper throughout the country, and you may well believe that the task was not an easy one. The Democratic and independent newspapers, however, co-operated very generously, and at the close of the campaign we figured that we had obtained fully 500,000 inches of display advertising for Wilson, without the expenditure of a dollar to the campaign committee.

"I might add that Colonel Robert Ewing, proprietor of the New Orleans States, who represented the committee in conducting this advertising campaign, estimated that fully 95,000 individuals contributed, and that, I am informed, is the largest number that ever contributed to one campaign fund."

* * *

The campaign fund collected by advertising, for this campaign committee, consisted of small contributions, which eliminated any of the accusations of dishonesty and corporation control of funds which fly so thick toward all parties in campaign years.

So it is with any proposition or product. The man who comes out in the open and advertises his wares generally has honest goods; otherwise, he could not afford to turn on them the glare of public criticism, education, and investigation.

Just rack your brain for a moment. Think of the biggest and most reliable manufacturer of power-plant goods you know of. He is an advertiser? Sure!

Next, read through the Advertising Pages of Practical Engineer. Select from among the advertisements the names of those products you have used. Isn't every one of them good?

An advertisement is practically an insurance policy of product-quality.